भारतीय मानक
Indian Standard

IS 8148 : 2018
(Reaffirmed 2022)

डक्टेड और पैकेज एयर-कंडीशनर — विशिष्टि

(दूसरा पुनरीक्षण)

Ducted and Package Air-Conditioners — Specification

(Second Revision)

ICS 23.120

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1976 and subsequently revised in 2003. The experience gained in implementation of this standard necessitates this revision and certain changes that are necessary are incorporated in this revision.

The methods of test for room air conditioners of capacity up to 10 500 W is specified in 1S 1391 (Part 1) : 2017 'Room air conditioners — Specification: Part 1 Unitary air conditioner' and up to 18 000 W is specified in IS 1391 (Part 2) : 2018 'Room air conditioners — Specification: Part 2 Split air conditioners'. This standard has been prepared to test ducted unitary and ducted split air conditioner of capacity above 3 500 W by psychometric and other methods of test suitable for such units.

In the formulation of this standard considerable assistance has been derived from the following International Standards:

ISO 13253 : 2017	Ducted air-conditioners and air-to-air heat pumps — Testing and rating for performance
ISO 16358 (Part 1) : 2013	Testing and calculating methods for seasonal performance factors of air-cooled air conditioners and air-to-air heat pumps — Part 1: Cooling seasonal performance factor

The quantities have been expressed in International System of Units (SI). The basic units of measurement together with their symbols for the various quantities used in the text have been listed in Annex H.

The composition of the committee responsible for the formulation of this standard is given in Annex J.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DUCTED AND PACKAGE AIR — CONDITIONERS — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This Standard specifies performance testing, the standard conditions and the test methods for determining the capacity and efficiency ratings of air-cooled air-conditioners and air-to-air heat pumps. This Standard is applicable unitary and split ducted air conditioners having air-cooled and water cooled condenser, and ducted air to air heat pumps.

1.2 This standard is applicable for:

a) Residential and commercial unitary and split air conditioners and heat pumps;
b) Utilizing single stage, two stage, multi stage and variable capacity components;
c) Single refrigeration system having nominal cooling capacity 3 500 W and above with one evaporator and one condenser, controlled by a single thermostat/controller; and
d) Multiple split system utilizing one or more refrigeration systems controlled by a single thermostat/controller:
   1) One outdoor and one or more indoor units, or
   2) One or more outdoor and one indoor unit.

1.3 This Standard is not applicable to the rating and testing of the following:

a) Water-source heat pumps;
b) Multi-split-system air-conditioners and air-to-air heat pumps (VRF);
c) Mobile (windowless) units having a condenser exhaust duct;
d) Individual assemblies not constituting a complete refrigeration system;
e) Equipment using the absorption refrigeration cycle; and
f) Non-ducted equipment (*see* IS 1391 part 1 and 2 for testing of such equipment).

2 REFERENCES

The standards listed below contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
101 (Part 6/ Sec 1) : 1988	Methods of sampling and test for paints, varnishes and related products: Part 6 Durability tests, Section 1 Resistance to humidity under conditions of condensation (*third revision*)
302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General requirements *(sixth revision)*
996 : 2009	Single-phase a.c. industrial motors for general purpose (*third revision)*
1391 (Part 1) : 2017	Room air conditioners — Specification: Part 1 Unitary air conditioners (*third revision)*
1391 (Part 2) : 2018	Room air conditioners — Specification: Part 2 Split air conditioners (*third revision*)
12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency
12615 : 2018	Line operated three phase a.c. motors (IE CODE) "efficiency classes and performance specification" (*third revision*)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

3.1 Packaged Air Conditioner — The unit for which the condenser is built as a separate package for remote field installation and interconnection shall be considered as a packaged air conditioner. It is an encased assembly as a self-contained unit primarily for floor mounting designed to provide free delivery of conditioned air to an enclosed space, room, or zone (conditioned space). It includes a prime source of refrigeration for cooling and dehumidification and means for the circulation and cleaning of air, with or without external air distribution ducting. These machines are equipped with either water-cooled or air-cooled condenser.

3.2 Ducted Air Conditioner — An encased factory-made assembly or assemblies designed primarily to provide conditioned air to enclosed space (s) through a duct. It includes a prime source of refrigeration for cooling and dehumidification and means for the circulation and cleaning of air. This may be provided in more than one assemble, the separated assemblies which are designed to be used together.

3.3 Ducted Heat Pump — An encased factory made assembly or assemblies designed to provide conditioned air to enclosed space (s) through a duct. It includes a prime source of refrigeration for heating and means for the circulation and cleaning of air. This may be provided in more than one assemble, the separated assemblies which are designed to be used together.

3.4 Two (2)-stage Capacity Unit — Equipment where the capacity is varied by no more than two steps. This definition applies to each cooling and heating operation individually.

3.5 Multi-stage Capacity Unit — Equipment where the capacity is varied by 3 or 4 steps. This definition applies to each cooling and heating operation individually.

3.6 Variable Capacity Unit — Equipment where the capacity is varied to represent continuously variable capacity. This definition applies to each cooling and heating operation individually.

3.7 Standard Air — Dry air at 20.0°C, and standard barometric pressure 10 332.275 kgf/m^2 (101.325 kPa), having a mass density of 1 204 kg/m^3.

3.8 Wet Bulb Temperature — Temperature indicated when the temperature-sensing element and wetted wick have reached a state of constant temperature (evaporative equilibrium) and when air is flowing over the cotton wick at a velocity of 5 to 10 m/s, wick is wetted with continuous source of distilled water.

3.9 Discharge Air Flow of a Unit — Outlet of the indoor unit of split system or indoor side of the unitary system.

3.10 Nominal Water Flow Rate — Rate of water flow through the condenser of water-cooled unit under capacity rating test conditions.

3.11 Heating Capacity — Amount of heat that the equipment can add to the conditioned space in a defined interval of time expressed in watts.

3.12 Total Cooling Capacity — Total available capacity of the unit for removing of sensible and latent heat from the space to be conditioned in a defined interval of time.

3.13 Latent Cooling Capacity (Net Dehumidifying Effect) — Amount of latent heat that equipment can remove from conditioned space in a defined interval of time expressed in watts.

3.14 Sensible Cooling Capacity — Amount of sensible heat that equipment can remove from conditioned space in a defined interval of time expressed in watts.

3.15 Sensible Heat Ratio — Ratio of the sensible cooling capacity to the total cooling capacity.

3.16 Indian Seasonal Energy Efficiency Ratio (ISEER) — Ratio of the total amount of heat that equipment can remove from the indoor air when operated for cooling in active mode to the total amount of energy consumed by equipment during the same period.

3.17 Full-load Operation — Operation with the equipment and controls configured for the maximum continuous duty refrigeration capacity specified by the manufacturer and allowed by the unit controls

3.18 Cooling Seasonal Total Load (CSTL) — Annual amount of heat that is removed from indoor air when equipment is operated for cooling active mode.

3.19 Cooling Seasonal Energy Consumption (CSEC) — Total annual amount of energy consumed by equipment when it is operated for cooling active mode.

3.20 Test Room — Room or space in which the unit is installed for test, with conditioning apparatus to ensure proper temperatures of air and water entering the unit, In case of water-cooled unit single room is required for the evaporator side along with water handling equipment to feed water into the condenser at desired temperature and rate of flow. In case of air-cooled unit two rooms are required, one for evaporator side and the other for condenser side, each with appropriate conditioning apparatus.

3.21 Rated Voltage and Frequency — Voltage and frequency shown on the name plate or as per IS 12360.

4 CONSTRUCTION (GENERAL)

4.1 The unit shall be constructed with sufficient strength and rigidity to withstand normal manual and mechanical handling, transportation and usage without damage or failure.

4.2 All parts that require periodic cleaning or maintenance shall be easily accessible when the unit is installed in accordance with manufacturer's instructions. These shall be resistant to corrosion and withstand neutral salt spray test for 72 h in accordance with 3 of IS 101 (Part 6/Sec 1).

4.3 Units shall be free from undue noise and vibration.

4.4 All parts that constitute an accident hazard shall be effectively guarded.

4.5 An adequate method of condensate removal shall be provided. There shall be condensate tray of adequate size

so that no water overflows. The tray and drain shall be made of corrosion-resistant material, or suitably treated with corrosion-resistant coating to withstand neutral salt spray test for 72 h in accordance with 3 of IS 101 (Part 6/Sec 1). The tray shall be adequately insulated to avoid condensation over its external surface.

4.6 Pipes and connections to resiliently mounted parts shall be so arranged as not to foul or to transmit undue vibrations to other parts and shall be so designed as to prevent failure due to fatigue. All other pipes and connections shall be securely anchored.

4.7 Suitable means shall be provided to prevent water condensed on cold parts of the refrigerating system from affecting the operation of the unit or its controls. Pipes shall be suitably insulated, wherever necessary.

4.8 Water-cooled condenser shall have cleanable water passages, either by mechanical means or chemical or both. An adequate opening shall be provided in the casing so as to have access to the passage: bearing water, from either end, for the design amenable to mechanical cleaning.

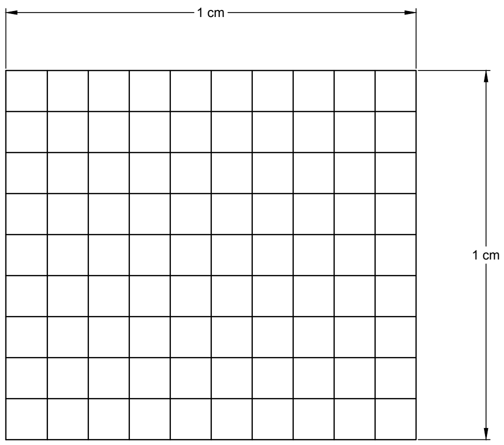
4.9 A suitable size refrigerant strainer shall be incorporated in the liquid line immediately before the expansion device.

4.10 All valves and refrigeration piping shall be properly clamped so as to avoid excessive vibrations.

4.11 Air Filter

The air filter with following specifications shall which may be made from synthetic or any other suitable material.

Mesh size: 10 × 10 per sq. cm and maximum open area 65 percent ± 5 (after reducing wire size from total area).



5 RATING REQUIREMENTS

5.1 Performance Requirements

The total cooling capacity/heating capacity of tested unit shall have a capacity not less than 90 percent of the rated capacity.

5.2 Cooling Capacity Ratings

Cooling capacity ratings shall be based on tests conducted under conditions specified in **7.1** and with apparatus described in **10**. Ratings shall include the total cooling capacity.

5.3 Discharge Air Flow Ratings

The airflow rate shall be measured when only the fan is operating, at an ambient temperature between 20°C to 30°C and relative humidity between 30 percent and 70 percent. The airflow settings of the units shall be same as cooling capacity test clause **7.1**.

5.4 External Static Pressure Rating (ESP)

5.4.1 If the rated ESP specified by the manufacturer is greater than or equal to the minimum value given in Table 1, the specified rated ESP is used as the ESP for rating.

5.4.2 If the rated ESP specified by the manufacturer is less than the minimum value given in Table 1, then the value of Table 1 is used as ESP for rating.

5.4.3 If the rated ESP is not specified by the manufacturer, the value of Table 1 is used as the ESP for rating.

Table 1 ESP Requirement for Comfort Air-conditioners

(*Clause* 5.4)

Sl No.	Standard Capacity Rating, kW	Minimum External Static Pressure, Pa
(1)	(2)	(3)
i)	$0 < Q < 9$	10
ii)	$9 \leq Q < 14$	20
iii)	$14 \leq Q < 30$	30
iv)	$30 \leq Q < 60$	40
v)	$60 \leq Q < 82$	60
vi)	$82 \leq Q < 117$	100
vii)	$117 \leq Q < 147$	125
viii)	$Q > 147$	150

5.5 Water Cooled Condenser Cooling Medium Flow Rating

The water flow rating for condenser shall be specified by the manufacturer, in m^3/h. Rated Flow of cooling water shall be maintained for the condenser during test conducted as per **7.1** to **7.6**. If the flow rate is not specified by manufacturer, then flow rate 0.2 m^3/h per kW shall be calculated for testing purposes.

5.6 Heating Capacity Rating

Heating capacity ratings shall be based on tests conducted under conditions specified in **7.7** and with apparatus described in **10**.

5.7 Electrical Ratings

Ratings, in watts, for packaged air conditioner shall be based on rated voltage. The units, however, shall be capable of working at any voltage within ±10 percent of the rated voltage.

6 BASIS OF RATINGS

Following information shall be furnished by the manufacturer as and when desired:

a) Manufacturer's name and address;
b) Model, size or type;
c) Total cooling capacity;
d) Discharge air flow capacity and external static pressure (ESP);
e) Water flow rate for condenser in m^3/h ;
f) Name of refrigerant;
g) Weight of the refrigerant charged into the unit (for a given pipe length);
h) Total power input;
j) Name plate ratings of each motor as per IS 996 for single phase and IS 12615 for 3 phase; and
k) Manufacturer's installation and operating instructions.

NOTE — All capacity ratings and power input shall be under the same conditions as for capacity rating test.

7 RATING AND TEST CONDITIONS

7.1 Capacity Rating Test Condition

The package air conditioner shall have nameplate rating determined by test conducted at the standard rating condition specified below:

a) Evaporator side inlet air temperature:
   1) Dry bulb 27°C
   2) Wet bulb 19°C
b) Condenser side inlet air temperature:
   1) Dry bulb 35°C
   2) Wet bulb 24°C**
c) Inlet water temperature 30°C
d) Condenser water flow rate As specified by manufacturer or 0.2 m^3/h
e) Test voltage Rated voltage
f) Test frequency Rated frequency

** The wet-bulb temperature condition shall be required only when testing air-cooled condensers that evaporate the condensate.

7.2 ISEER Test Conditions

For ISEER test conditions refer to Table 2.

7.3 Maximum Operating Test Condition

The maximum operating tests shall be conducted under the conditions specified below:

a) Evaporator side inlet air temperature:
   1) Dry bulb 35°C
   2) Wet bulb 24°C

Table 2 ISEER Test Conditions

(*Clause* **7.2)**

Sl No.	Test	Characteristics	Fixed	Two-Stage	Multi-Stage	Variable	Default Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Standard cooling capacity Indoor DB 27°C WB 19°C Outdoor DB 35°C	Full capacity $Ø_{ful}$ (35) (W) Full power input P_{ful} (35) (W)	■	■	■	■	
		Half capacity $Ø_{ful}$ (35) (W) Half power input P_{ful} (35) (W)	—	—	O	■	$Ø_{haf}(29)/1.077$ $P_{haf}(29)/0.914$
■ Required test O Optional test							
ii)	Low temperature cooling capacity	Full capacity $Ø_{ful}$ (29) (W) Full power input P_{ful} (29) (W)	O	O	O	—	$1.077 * Ø_{ful}(35)$ $0.914 * P_{haf}(35)$
	Indoor DB 27°C WB 19°C	Half capacity $Ø_{ful}$ (29) (W)	—	—	O	O	$1.077 * Ø_{ful}(35)$
	Outdoor DB 29°C	Half power input P_{ful} (29) (W)					$1.077 * Ø_{ful}(35)$
		Minimum capacity $Ø_{ful}$ (29) (W) Minimum power input P_{ful} (29) (W)	—	O	O	O	—
■ Required test O Optional test							

b) Condenser side inlet air temperature:
   1) Dry bulb — 46°C
   2) Wet bulb — 27°C***
c) Inlet water temperature — 34°C
d) Water flow rate — As specified by manufacturer or 0.2 m^3/h
e) Test voltage:
   1) For units with a single voltage rating — 90 and 110 percent of rated voltage
   2) For units with a dual voltage rating — 90 percent of lower rated voltage and 110 percent of higher rated voltage
f) Test frequency — Rated frequency

*** The wet-bulb temperature condition shall be required only when testing air-cooled condensers that evaporate the condensate.

7.4 Freeze-up Test Conditions

Freeze-up tests shall be conducted under the conditions specified below:

a) Evaporator side inlet air temperature:
   1) Dry bulb — 21°C
   2) Wet bulb — 15°C
b) Condenser side inlet air temperature:
   1) Dry bulb — 21°C
c) Inlet water temperature — 19°C
d) Water flow rate — As specified by manufacturer or 0.2 m^3/h
e) Test voltage — Rated voltage
f) Test frequency — Rated frequency

7.5 Enclosure Sweat Test Conditions

The enclosure sweat test shall be conducted under the conditions given below:

a) Evaporator side inlet air temperature:
   1) Dry bulb — 27°C
   2) Wet bulb — 24°C
b) Condenser side inlet air temperature:
   1) Dry bulb — 27°C
c) Inlet water temperature — 27°C
d) Water flow rate — As specified by manufacturer or 0.2 m^3/h
e) Test voltage — Rated voltage
f) Test frequency — Rated frequency

7.6 Condensate Disposal Test Conditions

Condensate disposal test shall be conducted under the same conditions as those specified for enclosure sweat tests (*see* **7.5**).

7.7 Heating Capacity

For heating capacity rating conditions refer to Table 3.

8 PERFORMANCE REQUIREMENTS

8.1 Capacity Rating Test

8.1.1 *General Conditions*

8.1.1.1 All equipment within the scope of this document shall have the cooling capacities and Indian seasonal energy efficiency ratios (ISEERs) determined in accordance with the provisions of this document and rated at the cooling test conditions specified in **7.1** and **7.7**. All tests shall be carried out in accordance with the requirements of Annex B and the test methods specified

Table 3 Heating Capacity Rating Conditions

(*Clauses* 7.7 *and* 9.1.1.4)

Sl No.	Parameter	Standard Rating Conditions[a]
(1)	(2)	(3)
i)	Temperature of air entering the indoor-side:	
	a) dry-bulb	20 °C
	b) wet-bulb (maximum)	15 °C
ii)	Temperature of air entering the outdoor- side:	
	a) dry-bulb	7 °C
	b) wet-bulb	6 °C
iii)	Test frequency[b]	Rated frequency
iv)	Test voltage	Rated voltage

[a] If a defrosting cycle occurs during the heating capacity test, testing under these conditions shall be accomplished using either the calorimeter or the indoor air enthalpy method (*see* Annexes D and E).

[b] Equipment with dual-rated frequencies shall be tested at each frequency.

in **10**. All tests shall be conducted with the equipment functioning at full-load operation, as defined in **3.17**. The electrical input values used for rating purposes shall be measured during the cooling capacity test.

8.1.1.2 If the manufacturer of equipment having a variable-speed compressor does not provide information on the full-load frequency and how to achieve it during a cooling capacity test, the equipment shall be operated with its thermostat or controller set to its minimum allowable temperature setting.

8.1.1.3 Test results shall be used to determine capacities without adjustment for permissible variations in test conditions except as specified for deviations from standard barometric pressure.

8.1.1.4 Capacities may be increased by 2.4 percent for each 10 kPa of barometric reading below 101.325 kPa at which the tests were conducted.

8.1.1.5 *Procedures*

Test methods are as per **10**. The air conditioner shall be tested in test room complying with Annex B.

Test conditions shall be maintained until equilibrium has been reached and maintained for not less than one hour, before recording data for capacity test. The test shall then be run for 1 h recording 7 sets of data at equal interval.

The following minimum data to be recorded for this test.

a) Data to be recorded – Air cooled cooling/heating unit:
    1) Date and time;
    2) Observations;
    3) Barometric pressure, in kPa;
    4) Equipment name plate data;
    5) ESP to evaporator air flow, in Pa;
    6) Power input to equipment, in watts;
    7) Applied voltages;
    8) Frequency;
    9) Fan speed setting;
    10) Dry bulb temperature of air entering equipment;
    11) Wet bulb temperature of air entering equipment;
    12) Dry bulb temperature of air leaving equipment (applicable for air enthalpy test method);
    13) Wet bulb temperature of air leaving equipment (applicable for air enthalpy test method); and
    14) Discharge air flow rate (applicable for air enthalpy test method).
b) Data to be recorded – Water cooled air-conditioner unit:
    1) Date and time;
    2) Observations;
    3) Barometric pressure, in kPa;
    4) Equipment name plate data;
    5) ESP to evaporator air flow, in Pa;
    6) Power input to equipment – watts;
    7) Applied voltages;
    8) Frequency;
    9) Fan speed setting;
    10) Dry bulb temperature of air entering equipment;
    11) Wet bulb temperature of air entering equipment;
    12) Dry bulb temperature of air leaving equipment;
    13) Wet bulb temperature of air leaving equipment;
    14) Discharge air flow rate;
    15) Condenser inlet water temperature; and
    16) Condenser water flow rate;

8.2 ISEER

ISEER calculation shall be done as per Annex F

8.3 Maximum Cooling Conditions Test

8.3.1 *Purpose*

The purpose of this test is to prove that the air conditioner is capable of operating satisfactorily under maximum operating conditions.

8.3.2 *Test Condition*

The maximum operating conditions test shall be conducted under the conditions specified in **7.3.** The unit's controls should be set for maximum cooling.

8.3.3 *Voltage*

Adjustment test voltage shall be as specified in **7.3**. These voltages shall be maintained at the rated voltages ±1 percent under running conditions. The electrical service supplied to the unit service connection shall be such that the voltage will not rise more than 3 percent when the unit is stopped.

8.3.4 *Procedure*

The air conditioner shall be operated continuously for 1 h after the specified air temperatures and equilibrium condensate level have been established. All power to the air conditioner shall then be cut off for 3 min and then restored for 1 h.

8.3.5 *Requirements*

8.3.5.1 During one entire test, the air conditioner should operate without visible or audible indication of damage.

8.3.5.2 The air conditioner motors should operate continuously for the first 1 h of the test without tripping of the motor overload protective devices.

8.3.5.3 The motor overload protective device may trip only during the first 5 min after the shut-down period of 3 min. During the remainder of that 1 h test period, no motor overload device shall trip.

8.3.5.4 For the models so designed that resumption of operation does not occur after initial trip within the first 5 min, the unit may remain out of operation for not longer than 30 min. It shall then operate continuously for 1 h.

8.4 Freeze-Up Tests

8.4.1 *Purpose*

The air blockage test and drip test shall be conducted to determine the ability of the air conditioner to operate satisfactorily under conditions with the maximum tendency to frost or ice the evaporator.

8.4.2 *Test Conditions*

Freeze-up test shall be conducted under the conditions given in **7.4**. The unit's controls, fans speed, dampers and grills should be set to produce the maximum tendency to frost or ice the evaporator, provided such settings are not contrary to the manufacturer's operating instructions.

8.4.3 *Air Blockage Test*

8.4.3.1 *Procedure*

The test should be continuous, with the unit on the cooling cycle for 4 h after establishment of the specified temperature conditions.

8.4.3.2 *Requirements*

At the end of 4 h, the accumulation of ice or frost on the evaporator shall not obstruct the air passing through the evaporator coil.

8.5 Drip Test

8.5.1 *Procedure*

The units should be operated for 4 h with the room side air inlet covered to completely block the passage of air so as to attempt to achieve complete blockage of the evaporator coil by frost.

After the 4 h operating period, the unit shall be stopped and the air-inlet covering removed until the accumulation of ice or frost has melted. The unit shall then be turned on again, with the fan operating at the highest speed, for 5 min.

8.5.2 *Requirements*

During the test no ice shall drop from the unit, and no water shall drip or blow off the unit on the room side.

8.6 Enclosure Sweat Test

8.6.1 *Purpose*

The purpose of this tests to determine the resistance to sweating of the air-conditioner when operating under conditions of high humidity.

8.6.2 *Test Conditions*

An enclosure sweat test shall be conducted under the conditions specified in **7.5**. The unit's controls, fans, dampers and grillers shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to manufacturer's operating instructions.

8.6.3 *Procedure*

After establishment of the specified temperature conditions, the equipment shall be started with its condensate collection pan filled to the overflowing point, and the equipment shall be run until the condensate flow has become uniform and the unit shall be operated continuously for a period of 4 h.

8.6.4 *Requirements*

When operating under the test conditions specified in **7.5**, no condensed water shall drip, run or blow from the equipment.

8.7 Condensate Disposal Test

8.7.1 *Purpose*

The purpose of this test to determine the capability of the air conditioner to dispose of condensate. This test may be conducted concurrently with the enclosure sweat test (*see* **8.5**).

8.7.2 *Test Conditions*

A condensate disposal test shall be conducted under the conditions specified in **7.5.** The unit's controls, fans, dampers and grillers shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to manufacturer's operating instructions.

8.7.3 *Procedure*

After establishment of the specified temperature conditions, the air conditioner shall be started with its condensate collection pan filled to the overflowing point, and shall be operated continuously for 4 h after the condensate level has reached equilibrium.

8.7.4 *Requirement*

During this test, the air conditioner shall have the ability to dispose of all condensate and there shall be no dripping or blowing off of water from the unit such that the building or surroundings may become wet.

8.8 Power Consumption Test

8.8.1 *Purpose*

The purpose of the power consumption test is to determine the power consumption, in watts.

8.8.2 *Test Condition*

The power consumption shall determine during the capacity rating test (*see* **8.1**) under the condition given in **7.1**.

8.8.3 *Test Procedure*

The power consumption shall be the average power consumption in watts measured during the capacity rating test.

9 HEATING CAPACITY TESTS

9.1 Heating Capacity Tests

9.1.1 *General Conditions*

9.1.1.1 For all heating capacity tests, the requirements specified in Annex B shall apply. Testing shall be conducted using the method(s) and instrumentation that meet the requirements of **10.1** and **10.2**.

9.1.1.2 Selectable resistive elements used for heating indoor air shall be prevented from operating during all heating capacity tests, except those used only during a defrost cycle.

9.1.1.3 The test setup shall include instrumentation to allow measurement of the temperature change across the indoor coil. If using the indoor air enthalpy method, the same dry-bulb temperature sensors as used to measure capacity may be used. If using the calorimeter test method, the temperature change shall be determined using the sensors specified in Annex D.

9.1.1.4 Standard rating conditions for heating capacity tests are specified in Table 3.

9.1.1.5 Heating capacity tests shall be conducted with the heat pump functioning at full-load operation, as defined in **3.17**.

9.1.1.6 The manufacturer shall specify, for inverter-controlled compressors, the specific frequency that is needed to give full-load operation. The heat pump shall be maintained at this frequency for all heating capacity tests. If the manufacturer of a heat pump having a variable-speed compressor fails to provide information on the full-load operating frequency and how to achieve it during heating capacity tests, then the heat pump shall be operated with its thermostat or controller set to its maximum allowable temperature setting.

9.1.2 *Requirements when Testing Heat Pumps that Provide Both Cooling and Heating*

9.1.2.1 Equipment settings shall be the same as those established during the cooling capacity tests.

9.1.2.2 Heating capacity tests shall be conducted with the same setting of the damper or exhaust fan as for the cooling capacity test.

9.1.3 *Requirements when Testing Heating-only Heat Pumps*

9.1.3.1 On the outdoor-side of the heat pump, all resistance elements associated with inlets, louvers, and any ductwork and attachments considered by the manufacturer as normal installation practice shall be installed.

9.1.3.2 On the indoor-side of the heat pump, damper positions, fan speed, etc. shall be set in accordance with the manufacturer's published installation instructions that are provided with the equipment. In the absence of such installation instructions, damper positions, fan speed, etc. shall be set to provide the maximum heating capacity when testing at the temperature conditions as per Table 3.

9.1.4 *Defrost Operation*

9.1.4.1 Overriding of automatic defrost controls shall be prohibited. The controls may only be overridden when manually initiating a defrost cycle during preconditioning.

9.1.4.2 Any defrost cycle, whether automatically or manually initiated, that occurs while preparing for or conducting a heating capacity test shall always be automatically terminated by the heat pump defrost controls.

9.1.4.3 If the heat pump turns the indoor fan off during the defrost cycle, airflow through the indoor coil shall cease.

9.1.5 *Test Procedure — General*

The test procedure consists of three periods: a preconditioning period, an equilibrium period, and a data collection period. The duration of the data collection period differs depending upon whether the heat pump's operation is steady-state or transient.

9.1.6 *Preconditioning Period*

9.1.6.1 The test room preconditioning apparatus and the heat pump under test shall be operated until the test tolerances specified in **10.2** are attained for at least 10 min.

9.1.6.2 A defrost cycle may end a preconditioning period. If a defrost cycle does end a preconditioning period, the heat pump shall operate in the heating mode for at least 10 min after defrost termination, prior to beginning the equilibrium period.

9.1.7 *Equilibrium Period*

9.1.7.1 The equilibrium period immediately follows the preconditioning period.

9.1.7.2 A complete equilibrium period is 1 h in duration.

9.1.7.3 The heat pump shall operate while meeting the test tolerances in **10.2**.

9.1.8 *Data Collection Period*

9.1.8.1 The data collection period immediately follows the equilibrium period.

9.1.8.2 Data shall be collected as specified in **10.1** for the chosen test method(s). If using the calorimeter method, heating capacity shall be calculated as specified in Annex D. If using the indoor air enthalpy method, the heating capacity shall be calculated as specified in Annex E.

9.1.8.3 An integrating electrical power (watt-hour) meter or measuring system shall be used for measuring the electrical energy supplied to the equipment. During defrost cycles and for the first 10 min following a defrost termination, the meter or measuring system shall have a sampling rate of at least every 10 s.

9.1.8.4 Except as specified in **9.1.8.3** and **9.1.8.5**, data shall be sampled at equal intervals that span 30 s or less.

9.1.8.5 During defrost cycles, plus the first 10 min following defrost termination, certain data used in evaluating the integrated heating capacity of the heat pump shall be sampled at equal intervals that span 10 s or less. When using the indoor air enthalpy method, these more frequently sampled data include the change in indoor-side dry-bulb temperature. When using the calorimeter method, these more frequently sampled data include all measurements required to determine the indoor-side capacity.

9.1.8.6 For heat pumps that automatically cycle off the indoor fan during a defrost, the contribution of the net heating delivered and/or the change in indoor-side dry-bulb temperature shall be assigned the value of zero when the indoor fan is off, if using the indoor air enthalpy method. If using the calorimeter test method, the integration of capacity shall continue while the indoor fan is off.

9.1.9 *Heating Capacity Test Results*

9.1.9.1 The electrical energy supplied to the heat pump during the test shall be recorded, along with the corresponding elapsed time, at the termination of each defrost cycle during the data collection period, if applicable, and at the termination of the data collection period.

9.1.9.2 Average heating capacity and average electrical power input shall be calculated in accordance with **9.1.1**.

9.2 Maximum Heating Performance Test

9.2.1 *General Conditions*

The conditions given in Table 4 shall be used during the maximum heating performance test. The test shall be conducted with the equipment functioning at full-load operation, as defined in **3.17**.

The test voltages in Table 4 shall be maintained at the specified percentages under running conditions.

The determination of heating capacity and electrical power input is not required for this performance test.

9.2.2 *Temperature Conditions*

The temperature conditions given in Table 4 shall be used during these tests unless the manufacturer specifies higher temperature conditions in the manufacturer's equipment specification sheets.

Table 4 Maximum Heating Performance Test Conditions

(*Clause* 9.2)

Sl No.	Parameter	Standard Test Conditions
(1)	(2)	(3)
i)	Temperature of air entering the indoor-side:	
	— dry-bulb	27 °C
ii)	Temperature of air entering the outdoor-side:	
	— dry-bulb	24 °C
	— wet-bulb	18 °C
iii)	Test frequency[a)]	Rated frequency
iv)	Test voltage	a) 90 percent and 110 percent of rated voltage for equipment with a single nameplate voltage rating
		b) 90 percent of the lower rated voltage and 110 percent of the higher rated voltage for equipment with a dual or extended nameplate voltage

[a)] Equipment with dual-rated frequencies shall be tested at each frequency.

9.2.3 *Airflow Conditions*

The maximum heating performance test shall be conducted with an indoor-side fan speed setting as determined in **5.3** and Annex A. For heating-only heat pumps, the indoor-side fan speed shall be set as specified in **9.1.3.2**.

9.2.4 *Test Conditions*

9.2.4.1 *Preconditions*

The controls of the equipment shall be set for maximum heating. All ventilating air dampers and exhaust air dampers, if provided, shall be closed.

9.2.4.2 *Duration of test*

The equipment shall be operated for 1 h after the specified air temperatures have been attained from Table 4. The equipment shall be permitted to stop and start under the control of an automatic limit device, if provided.

9.2.5 *Performance Requirements*

The equipment shall operate under the conditions specified in Table 4, without indication of damage. The equipment shall be permitted to stop and start under the control of an automatic limit device, if provided. After the interruption of operation, the equipment shall resume operation within 30 min.

9.3 Automatic Defrost Performance Test

9.3.1 *General Conditions*

This test is not required if provision is made to ensure that cool air (less than 18°C) is not blown into the conditioned space during defrost. The test shall be conducted with the equipment functioning at full-load operation, as defined in **3.17,** except as required in **9.3.3.** The conditions for test frequency and test voltage given in Table 3 shall be used during the automatic defrost test. The determination of heating capacity and electrical power input is not required for this performance test.

9.3.2 *Temperature Conditions*

The temperature of air entering the indoor-side shall be set as specified in Table 3. The temperature of air entering the outdoor-side shall be set temperature of air entering the outdoor-side:

a) dry-bulb 2 °C

b) wet-bulb 1 °C

c) Airflow conditions — Unless prohibited by the manufacturer, the indoor-side fan is to be adjusted to the highest speed and the unit outdoor-side fan to the lowest speed, if separately adjustable. All other parameters shall be set as specified in **9.1.3.1**.

9.3.3 Unless prohibited by the manufacturer, the indoor-side fan is to be adjusted to the highest speed and the unit outdoor-side fan to the lowest speed, if separately adjustable. All other parameters shall be set as specified in **9.1.3.1**.

9.3.4 *Test Conditions*

9.3.4.1 *Duration of test*

The equipment shall be operated until the temperatures specified in **9.3.2** have been stabilized.

The heat pump shall remain in operation for two complete defrosting periods or for 3 h, whichever is longer.

9.3.5 *Performance Requirements*

During the defrosting period, the temperature of the air from the indoor-side of the equipment shall not be lower than 18°C for longer than 1 min.

10 METHODS AND TOLERANCES

10.1 Test Methods

10.1.1 *General*

Capacity tests shall be conducted in accordance with the testing requirements specified in Annex B using either the calorimeter test method (*see* Annex D) or the indoor air enthalpy test method (*see* Annex E).

10.1.2 *Calorimeter Test Method*

10.1.2.1 When using the calorimeter method as per Annex D for cooling capacity tests and for steady-state heating capacity tests, two simultaneous methods of determining capacities shall be used. One method determines the capacity on the indoor-side, the other measures the capacity on the outdoor-side. The capacity determined using the outdoor-side data shall agree to within 5 percent of the value obtained using the indoor-side data in order for the test to be valid.

10.1.2.2 Steady-state conditions are achieved when the measured capacity at each 5 min time interval does not vary by more than 2 percent from the average measured capacity over the previous 35 min.

10.1.2.3 The apparatus used to make the indoor-side airflow and static pressure measurements shall be located within the indoor-side test chamber of the calorimeter for all tests except for where the fixed duct resistance method specified in **A-3** is used for setting the airflow. In this case, the airflow measuring apparatus may be removed after the damper has been set in order to obtain the required airflow and external static pressure as specified in Annex A.

10.1.3 *Indoor Air Enthalpy Method*

Cooling capacity tests and steady-state heating capacity tests by using indoor air enthalpy test method as per Annex E.

10.2 Test Tolerances

10.2.1 All test observations shall be within the variations allowed as specified in Table 5, as appropriate to the test methods and type of equipment.

10.2.2 The maximum permissible variation of any observation during the capacity test is listed under 'maximum variation of individual reading from rating conditions' in Table 5. This represents the greatest permissible difference between maximum and minimum instrument observations during the test. When expressed as a percentage, the maximum allowable variation is the specified percentage of the arithmetical average of the observations.

10.2.3 Variations greater than those prescribed shall invalidate the test.

11 SOUND TEST

11.1 Test Purpose

Verify the sound pressure level (dB level) for indoor or outdoor units in connected conditions.

11.2 Temperature Conditions:

a) Test condition: Indoor : 27 ± 5°C and Outdoor : 35 ± 5°C
b) Power supply: Rated power of the units

11.3 Back Ground Noise

Minimum 10 dB lower than rated sound pressure level or 20 dB whichever is higher.

11.4 Test Equipment

a) dB meter for sound pressure level, or
b) Measuring Tape.

11.5 Equipment/Sensor Location for Sound Pressure Measurement:

a) Unit is installed as it is installed for cooling capacity test;
b) Unit controls should be set to full load capacity test conditions; and
c) Measurement to be done at point TP as shown in Fig. 1 and 2.

11.6 Method for Room Air Conditioner

Take average of 3 reading to arrive at sound pressure

11.7 Use attachments (duct, damper etc. for simulating site conditions)

12 TESTS

12.1 Tests shall be classified into the following three groups:

a) Production routine tests;
b) Type tests; and
c) Acceptance tests.

12.2 Production Routine Tests

These shall consist of routine tests that would be conducted on each and every unit after completion at the manufacturer's works.

Table 5 Variations Allowed During Steady-State Cooling and Heating Capacity Tests

(*Clause* 10.2.2)

Sl No.	Reading	Variations of Arithmetical Mean Values from Specified Test Conditions	Maximum Variation of Individual Readings from Specified Test Conditions
(1)	(2)	(3)	(4)
i)	Temperature of air entering the indoor-side:		
	a) dry-bulb	± 0.3 °C	± 0.5 °C
	b) wet-bulb	± 0.2 °C[1)]	± 0.3 °C[1)]
ii)	Temperature of air entering the outdoor-side:		
	a) dry-bulb	± 0.3 °C	± 0.5 °C
	b) wet-bulb	± 0.2 °C[2)]	0.3 °C[2)]
iii)	Voltage	± 1 percent	± 2 percent
iv)	Water temperature		
	a) inlet	± 0.1 °C	± 0.2 °C
	b) outlet	± 0.1 °C	± 0.2 °C
v)	Water volume flow rate	± 1 percent	± 1 percent
vi)	External resistance to airflow	± 5 Pa	± 10 Pa

1) Not applicable for heating tests.

2) Only applies to cooling capacity tests if equipment rejects condensate to the outdoor coil.

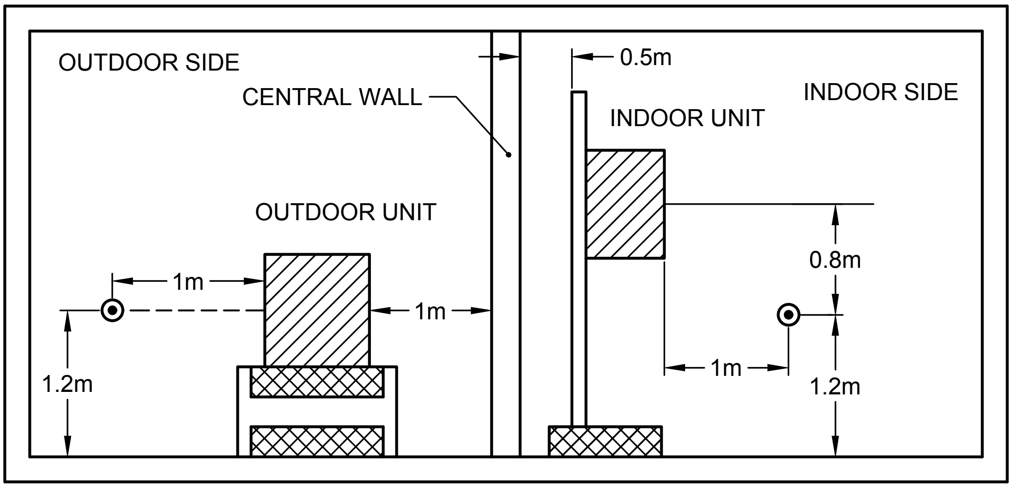


FIG. 1 DUCTED AIR CONDITIONER

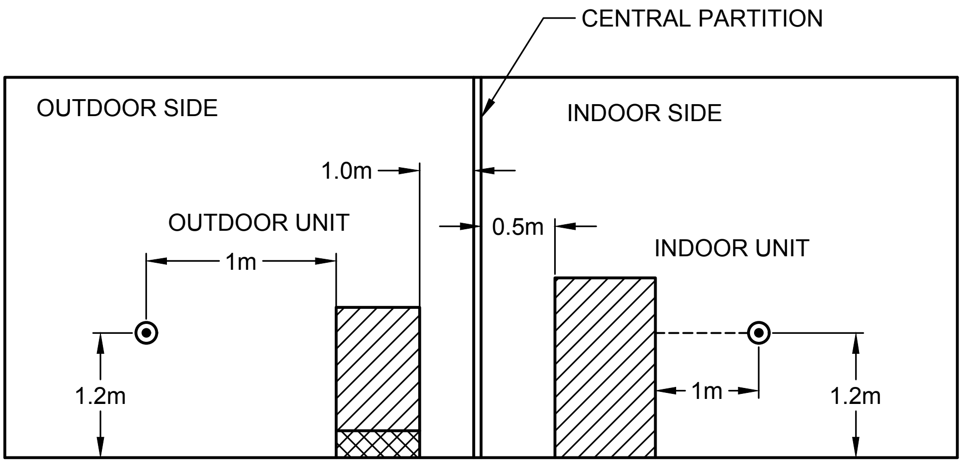


FIG. 2 PACKAGE AIR CONDITIONER

12.2.1 *Running Test*

a) Unitary unit — Each unit individually shall be given power supply and run to ensure vibration free running.

b) Split unit — Indoor unit (IDU) and outdoor units (ODU) shall be run separately (without connecting IDU and ODU) to check the fan/blower running only. Compressor need not to be run during this test.

12.2.2 *Pressure Test or Leakage Test*

Unitary unit to be checked for leakage either at appropriate pressure defined by manufacturer process sheet and sealed properly after leak test.

Indoor unit and outdoor unit can be leak checked separately at appropriate pressure defined by manufacturer process sheet and sealed properly after leak test.

12.2.3 *Insulation Resistance Test*

The insulation resistance between all electrical circuit and metal parts when measured at normal room temperature with a voltage of not less than 500 V dc shall not be less than 1 MΩ.

12.2.4 *High Voltage Test*

The electrical insulation of all circuits shall be such as to withstand a test voltage of 1 000 V_{rms} applied for not less than 1s and tested as per IS 302-1.

12.2.5 *Leakage Current Test*

The leakage current shall not exceed 3.5 mA when tested as per IS 302-1

12.2.6 *Earth Resistance Test*

The earth resistance of the unit shall not exceed 0.1 Ω when tested as per IS 302-1.

12.3 Type Tests

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components.

12.3.1 Besides all the production routine tests outlined in **12.2**, the type tests shall comprise the following:

a) Capacity rating and other tests specified in **8**; and
b) Room discharge air flow rating test in accordance with procedure given in Annex C and under conditions in **7.1**.

12.3.2 The type test report shall also contain the name-plate particulars of the air conditioners for purposes of identification.

12.3.3 *Safety Tests*

The following type safety tests to be carried out as per IS 302-1:

a) Protection against the live part;
b) Earth continuity test;
c) Electric strength test;
d) Functional tests;
e) Provision for earthing; and
f) Electrical insulation and leakage current at operating temperature.

12.4 Acceptance Test

If the purchaser desires any of the production routine tests to be repeated at the time of purchase, then, where agreed to between the purchaser and the manufacturer, the tests may be carried out at the manufacturer's works; alternatively the tests may be repeated at the place specified by the purchaser provided that all the arrangements for tests are made by the purchaser at the specified place.

12.5 Samples for Tests

The number of samples shall be as agreed.

13 MARKING

13.1 The packaged/ducted air conditioner shall have the following information marked in a nameplate in a permanent and legible manner in a location where it is accessible and visible:

a) Outdoor unit:
    1) Name and address of the manufacture;
    2) Type of model number and serial number of the unit;
    3) Power supply in V, phase and Hz;
    4) Full load amperage;
    5) Name and quantity of refrigerant charge;
    6) Nominal capacity, in W, under temperature conditions specified in this standard; and
    7) Power consumption, in W, at the normal operating conditions specified in this standard.
b) Indoor unit:
    1) Name and address of the manufacture;
    2) Type of model number and serial number of the unit;
    3) Power supply in V, phase and Hz; and
    4) Power consumption, in W, at the normal operating conditions specified in this standard.

13.2 BIS Certification Marking

Each ducted and package air-conditioner may also be marked with the Standard Mark.

13.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made there under. The details of the conditions under which the licence for use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clauses* 9.2.3 and 10.1.2.3)

AIRFLOW SETTINGS FOR DUCTED UNITS

A-1 GENERAL

Two methods of setting are applicable:

a) Fixed duct resistance method; and
b) Adjusted exhaust fan setting method.

Both methods, with their respective test apparatus, are described in this Annex.

To measure the static pressure of the discharge air from the ducted equipment, a measuring duct is connected to the duct flange of the equipment. This measuring duct is used for both methods. If the dimensions of the outlet duct section are A and B, the equivalent diameter, D_e, is determined using equation 1:

$$D_e = \sqrt{\frac{(4AB)}{\pi}} \quad \ldots 1$$

In the case that the outlet duct is circular in section with diameter, D, the equivalent diameter, D_e, is equal to D.

The length of the measuring duct, L_d, shall be no smaller than 2.5 D_e. The static pressure taps should be located at a distance $L_m = 2D_e$ from the outlet flange.

A-2 TEST METHOD

A-2.1 The flow setting of the units shall be by means of the fixed duct resistance method, as shown in Fig. 3, or the adjusted exhaust fan setting method, as shown in Fig. 4.

A-2.2 The static pressure measurement taps shall be arranged as shown in Fig. 3 and Fig. 4. The unit under test shall be operated without the compressor running.

A-2.3 Airflow measurements should be made in accordance with the provisions specified in Annex C, as appropriate, as well as other provisions established in this standard.

A-3 FIXED DUCT RESISTANCE METHOD

A-3.1 General

A measuring duct shall be connected to the test unit and a damper installed on the opposite end of the measuring duct, to which a discharge chamber is connected. The minimum length of the discharge chamber in the flow direction, J, is 2 D_e.

NOTE — The setup of the test unit, measuring duct and the discharge chamber is illustrated in Fig. 3.

A-3.2 Test Procedure

A-3.2.1 *Test Conditions*

The temperature and humidity conditions of the test room shall be within the range specified in **5.3**. The test unit shall be operated in the blowing mode without the compressor running. The damper shall be adjusted to get the ESP as per **5.4** and measure the air flow rate once the required ESP is achieved. At the same time, the airflow rate of the airflow measuring apparatus shall be adjusted so that static pressure in the discharge chamber is (0 ± 2) Pa. The above conditions shall be maintained for at least 30 min. External static pressure shall be maintained per Table 6 during the discharge air flow rate test.

A-3.2.2 *Discharge Air Flow Rate Test*

The dry and wet-bulb temperatures of the inlet air, airflow rate, ESP (p_e), dry and wet-bulb temperatures in front of the nozzle, and barometric pressure (p_a) shall be measured. The measured airflow rate, q_m, shall be calculated according to equation 5. The measured airflow rate, q_m, shall be converted into the standard flow rate, q_s according to equation 10.

A-3.2.3 *Evaluation*

The ESP, p_e, shall be that specified by **5.4.**

Table 6 Variation Allowed During Discharge Air Flow Rate Test

(*Clause* A-3.2.1)

Sl No.	Reading	Variation of Arithmetical Mean Values from Specified Test Conditions		Variation of Individual Readings from Specified Test Conditions	
		≤ 100 Pa	> 100 Pa	≤ 100 Pa	> 100 Pa
(1)	(2)	(3)	(4)	(5)	(6)
i)	External Static Pressure (ESP)	± 5 Pa	± 5 percent	± 10 Pa	± 10 percent

A-3.2.4 *Cooling and Heating Tests*

The damper's position shall remain fixed at the setting obtained in **A-3.2.1**, for all cooling and heating tests, which shall be conducted at the respective temperature and humidity conditions. During the cooling and heating tests, the static pressure of the discharge chamber shall be maintained at (0 ± 2) Pa.

The ESP, p_e, of the measuring duct at the cooling and heating tests is for reference only, and therefore it does not need to be published. The airflow rate measured when the equipment is operating in the cooling or heating mode is used for calculation of cooling and heating capacities.

A-4 ADJUSTED EXHAUST FAN SETTING METHOD

A-4.1 General

A measuring duct shall be connected to the test unit and an airflow measuring apparatus connected to the opposite end of the measuring duct.

NOTE — The setup of the test unit, measuring duct and the airflow measuring apparatus is illustrated in Fig. 4.

A-4.2 Test Procedure

The temperature and humidity conditions of the test room shall be within the range specified in **5.3**. The test unit is operated in the blowing mode without the compressor running. The air flow measuring apparatus shall be adjusted so that the required ESP as per **5.4** is obtained. The above conditions shall be maintained for at least 1 h. External static pressure shall be maintained per Table 6 during the blowing test.

A-4.3 Discharge Air Flow Rate Test

The dry and wet-bulb temperatures of the inlet air, airflow rate, ESP (p_e), dry and wet-bulb temperatures in front of the nozzle, and barometric pressure shall be measured. The measured airflow rate, q_m, shall be calculated according to equation 5. The measured airflow rate, q_m, shall be converted into the standard flow rate, q_s according to equation 10.

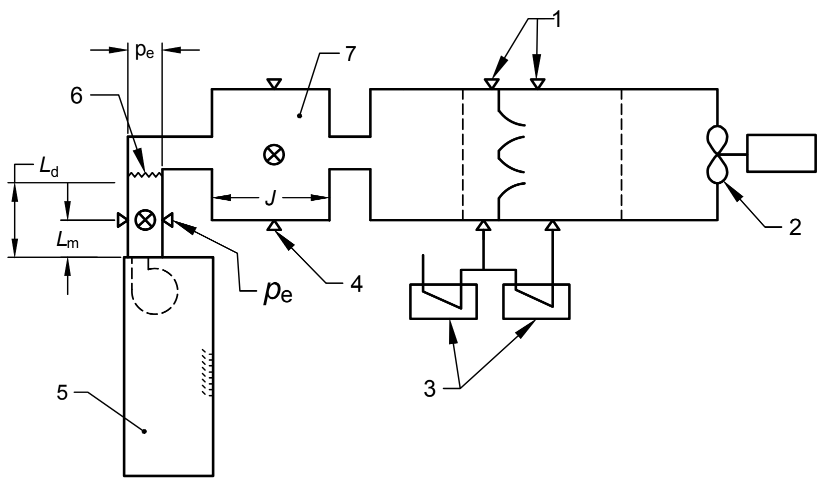
A-4.4 Calculation of the Value of *C*

Calculate the value of *C*, determined from equation 2:

$$C = \frac{p_m}{q_m^{\ 2}} \qquad \ldots 2$$

Where,

p_m is external static pressure at the measuring duct, Pa, especially for blowing test using adjusted exhaust fan setting method, and p_m is considered to be equal to the external static pressure, p_e.



KEY -

1 - AIRFLOW MEASURING APPARATUS
2 - EXHAUST FAN
3 - MANOMETERS
4 - STATICS PRESSURE TAPS OF DISCHARGE CHAMBER
5 - EQUIPMENT UNDER TEST
6 - DAMPER
7 - DISCHARGE CHAMBER
J - MINIMUM LENGTH
L_d - LENGTH OF MEASURING DUCT
L_m - DISTANCE TO STATIC PRESSURE TAPS
p_e - ESP OF THE EQUIPMENT UNDER TEST

FIG. 3 FIXED DUCT RESISTANCE METHOD — SETUP

A-4.5 Evaluation

The ESP, p_e, shall be that specified by **5.4.**

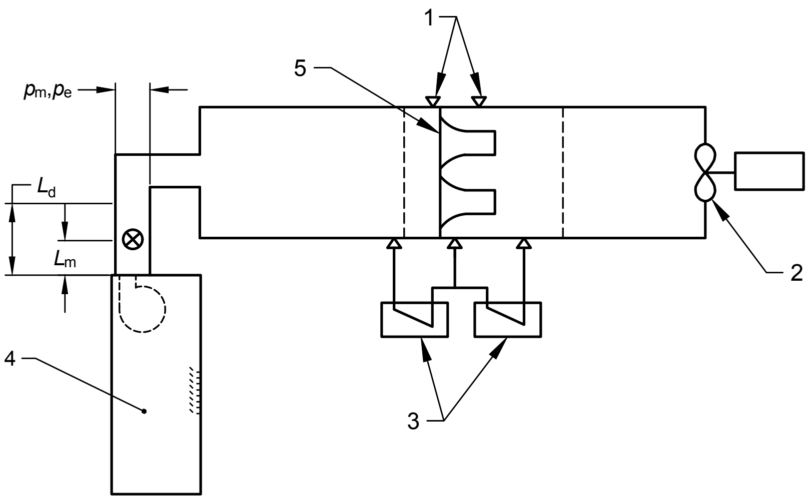
A-4.6 Cooling and Heating Tests

Cooling and heating tests shall be performed following the discharge air flow rate test, at their respective temperature and humidity conditions. The speed of the exhaust fan of the airflow measuring apparatus shall be adjusted for the cooling and heating tests to maintain the ESP as per **5.4.**

For the cooling test, operate the equipment with the compressor in the cooling mode and allow the temperature to stabilize.

For the heating test, repeat the cooling test above, except with the compressor operating in the heating mode.

The airflow rate measured when the equipment is operating in the cooling or heating mode shall be used for calculation of cooling and heating capacities.



KEY -

1 - AIRFLOW MEASURING APPARATUS

2 - EXHAUST FAN

3 - MANOMETERS

4 - EQUIPMENT UNDER TEST

5 - NOZZLES

L_d - LENGTH OF MEASURING DUCT

L_m - DISTANCE TO STATIC PRESSURE TAPS

p_e- ESP OF THE EQUIPMENT UNDER TEST

p_m - EXTERNAL STATICS PRESSURE AT THE MEASURING DUCT, SPECIALLY FOR BLOWING TEST USING ADJUSTED EXHAUST

FIG. 4 ADJUSTED EXHAUST FAN SETTING METHOD SETUP

ANNEX B

(*Clauses* 8.1.1.1, 9.1.1.1 *and* 10.1.1)

TEST REQUIREMENTS

B-1 GENERAL TEST ROOM REQUIREMENTS

B-1.1 If an indoor condition test room is required, it shall be a room or space in which the desired test conditions can be maintained within the prescribed tolerances. It is recommended that air velocities in the vicinity of the equipment under test do not exceed 2.5 m/s.

B-1.2 If an outdoor condition test room or space is required, it shall be of sufficient volume and shall circulate air in such a manner that it does not change the normal air circulating pattern of the equipment under test. It shall be of such dimensions that the distance from any room surface to any equipment surface from which air is discharged is not less than 1.8 m and the distance from any other room surface to any other equipment surface is not less than 1 m, except for floor or wall relationships required for normal equipment installation. The room conditioning apparatus should handle air at a rate not less than the outdoor airflow rate, and preferably should take this air from the direction of the equipment air discharge and return it at the desired conditions uniformly and at low velocities.

B-1.3 If the calorimeter room method is used with a facility having more than two rooms, then the additional rooms shall also comply with the requirements of Annex D. If the air enthalpy method is used with a facility having more than two rooms, the additional rooms shall also comply with the requirements of Annex E.

B-2 EQUIPMENT INSTALLATION

B-2.1 The equipment to be tested shall be installed in accordance with the manufacturer's installation instructions using recommended installation procedures and accessories. If the equipment can be installed in multiple positions, all tests shall be conducted using the least favorable configuration according to the manufacturer's recommendation. In all cases, the manufacturer's recommendations with respect to distances from adjacent walls, amount of extension through walls, etc. shall be followed.

B-2.2 Ducted equipment rated at less than 8 kW and intended to operate at an ESP, p_e, of less than 25 Pa shall be tested at free delivery of air according to IS 1391 (Parts 1 and 2).

B-2.3 No other alterations to the equipment shall be made except for the attachment of the required test apparatus and instruments in the prescribed manner.

B-2.4 If necessary, the equipment shall be evacuated and charged with the type and amount of refrigerant specified in the manufacturer's instructions.

B-2.5 All standard ratings for equipment in which the condenser and the evaporator are two separate assemblies shall be determined on the basis of the manufacturer's specifications within 5 m to 7.5 m of connecting tubing on each line. The lengths shall be actual lengths, not equivalent lengths, and no account shall be taken of the resistance provided by bends, branches, connecting boxes or other fittings used in the installation for the test piece. The length of the connecting tubing shall be measured from the enclosure of the indoor unit to the enclosure of the outdoor unit. Any equipment in which the interconnecting tubing is furnished as an integral part of the unit, and not recommended for cutting to length, shall be tested with the complete length of tubing furnished. Not less than 40 percent of the total length of the interconnecting tubing shall be exposed to the outdoor conditions with the rest of the tubing exposed to the indoor conditions. The line diameters, insulation, details of installation, evacuation and charging shall be in accordance with the manufacturer's published recommendations.

B-3 STATIC PRESSURE MEASUREMENTS ACROSS INDOOR COIL

B-3.1 Equipment with a Fan and a Single Outlet

B-3.1.1 A short plenum shall be attached to the outlet of the equipment. This plenum shall have cross-sectional dimensions equal to the dimensions of the equipment outlets. A static pressure tap shall be added at the centre of each side of the discharge plenum, if rectangular, or at four evenly distributed locations along the circumference of an oval or round plenum. These four static pressure taps shall be manifolded together. The minimum length of the discharge plenum and the location of the static pressure taps relative to the equipment outlets shall be as shown in Fig. 5, if testing a split-system, and as shown in Fig. 6, if testing a single-package unit.

B-3.1.2 A short plenum should be attached to the inlet of the equipment. If used, the inlet plenum shall have the same cross-sectional dimensions as the equipment inlet. In addition, four static pressure taps shall be added and manifolded together. This plenum should otherwise be constructed as shown for the inlet plenum in Fig. 6, if testing a single-package unit, and as shown in Fig. 7, if testing a split-system.

NOTE — Fig. 7 is referenced here for guidance even though it specifically applies to ducted units tested without an indoor fan.

B-3.2 Equipment with Fans and Multiple Outlets or Multiple Indoor Units

B-3.2.1 Equipment with multiple outlet duct connections or multiple indoor units shall have a short plenum attached to each outlet connection or indoor unit, respectively. Each of these short plenums shall be constructed as described in **B-3.1.1**, including static pressure taps. All outlet plenums shall discharge into a single common duct section. For the purpose of equalizing the static pressure in each plenum, an adjustable restrictor shall be located in the plane where each outlet plenum enters the common duct section. Multiple blower units employing a single discharge duct connection flange shall be tested with a single outlet plenum in accordance with **B-3.1**. Any other test plenum arrangements shall not be used except to stimulate duct designs specifically recommended by the equipment manufacturer.

B-3.2.2 A short plenum should be attached to the inlet of each inlet duct connection or indoor unit. Each of these short plenums shall be constructed as described in **B-3.1.2**, including static pressure taps.

B-3.3 Equipment without a Fan and a Single Outlet

For an indoor coil that does not incorporate a fan, a short plenum shall be attached to both the inlet and outlet of the equipment. These plenums shall have cross-sectional dimensions equal to the dimensions of the equipment inlet and outlet, respectively. A static pressure tap shall be added at the centre of each side of each plenum, if rectangular, or at four evenly distributed locations along the circumference of oval or round plenums. For each plenum, the four static pressure taps shall be manifolded together. The minimum length of the plenums and the location of the static pressure taps relative to the equipment inlet and outlet shall be as shown in Fig. 7.

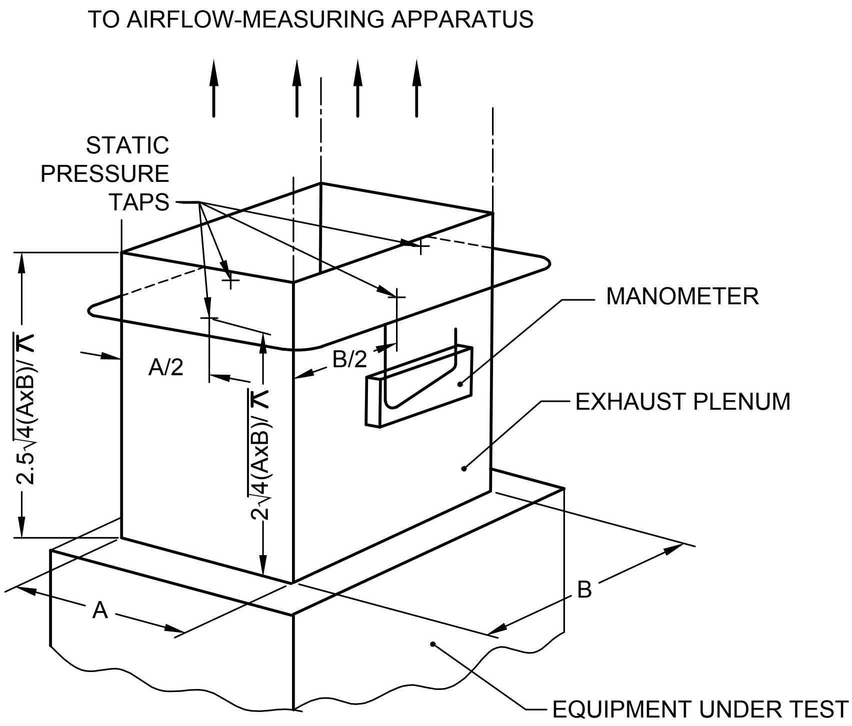
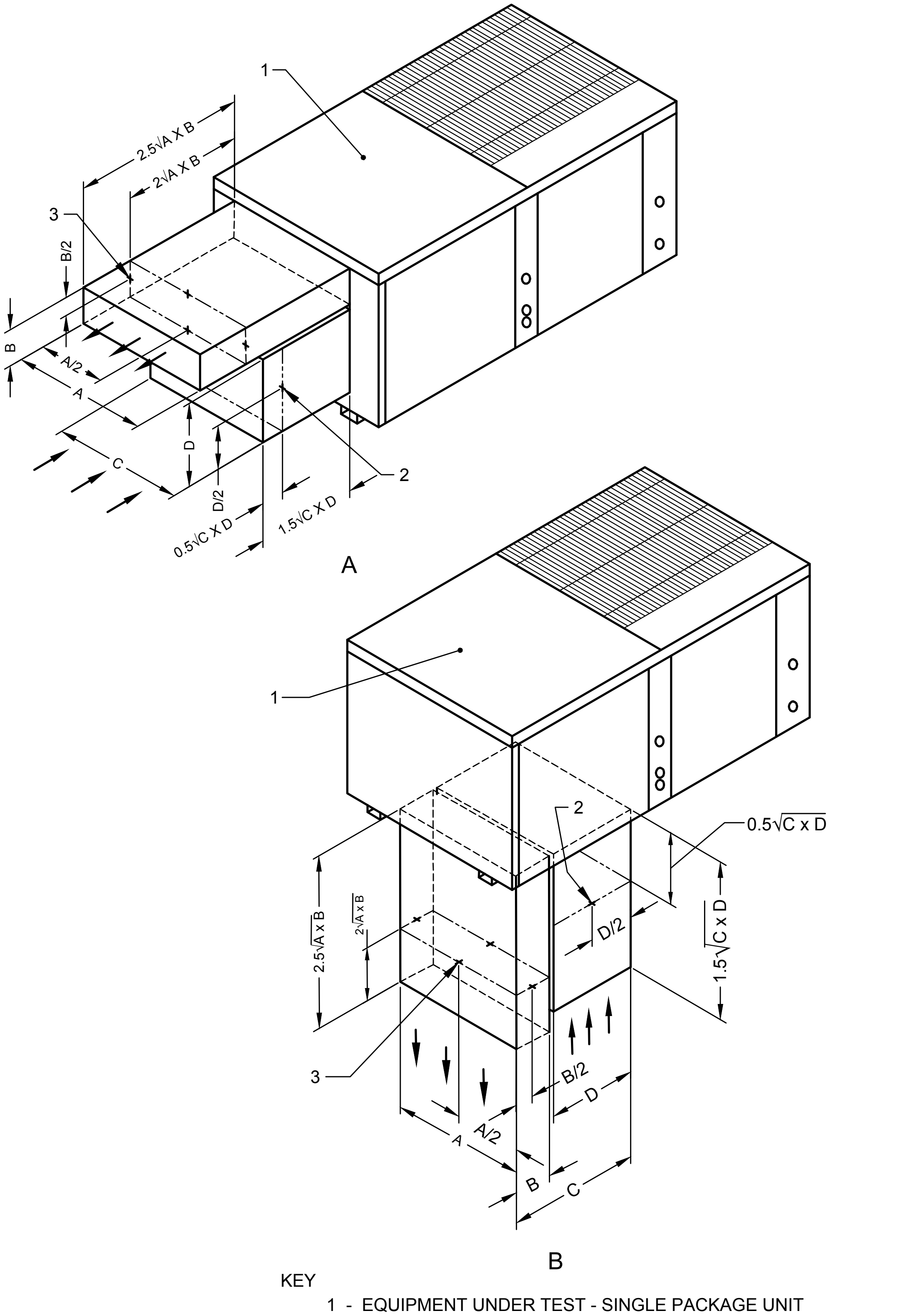


Fig. 5 ESP Measurement — Split System



KEY

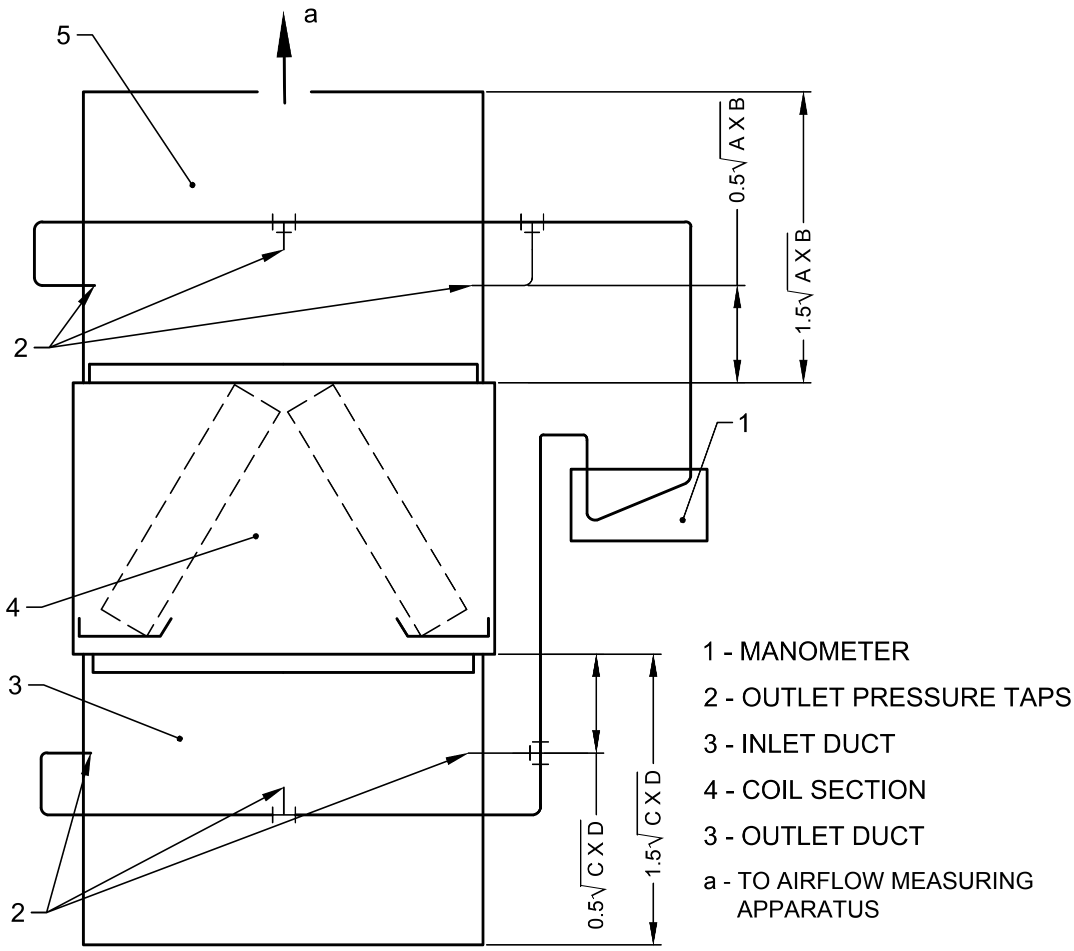
1 - EQUIPMENT UNDER TEST - SINGLE PACKAGE UNIT

2 - STATIC PRESSURE TAP, INLET (4 Nos.)

3 - STATIC PRESSURE TAP, OUTLET (4 Nos.)

NOTE - For circular ducts with diameter, *d*,substitute $\pi d^2/4$ for (A x B) or (C x D)

FIG. 6 ESP MEASUREMENTS — SINGLE PACKAGE



NOTE -

1 A and B are outlet dimensions; C and D are inlet dimensions

2 For circular ducts with diameter, D,substitute $\pi D_i^2/4$ for (C x D) and $\pi D_o^2/4$ (A xB), where D_i is inlet duct diameter and D_o is outlet duct diameter.

3 The length of the inlet duct, $5\sqrt{\text{C x D}}$ is a minimum dimension. for more precise results, use $4\sqrt{\text{C x D}}$

FIG. 7 AIR STATIC PRESSURE DROP MEASUREMENT OVER THE COIL FOR A COIL-ONLY UNIT

ANNEX C

(*Clause* 12.3.1)

AIRFLOW MEASUREMENT

C-1 AIRFLOW DETERMINATION

C-1.1 Airflow should be measured using the apparatus and testing procedures given in this annex.

C-1.2 Airflow quantities are determined as mass flow rates.

C-2 NOZZLE APPARATUS

C-2.1 Nozzle Apparatus

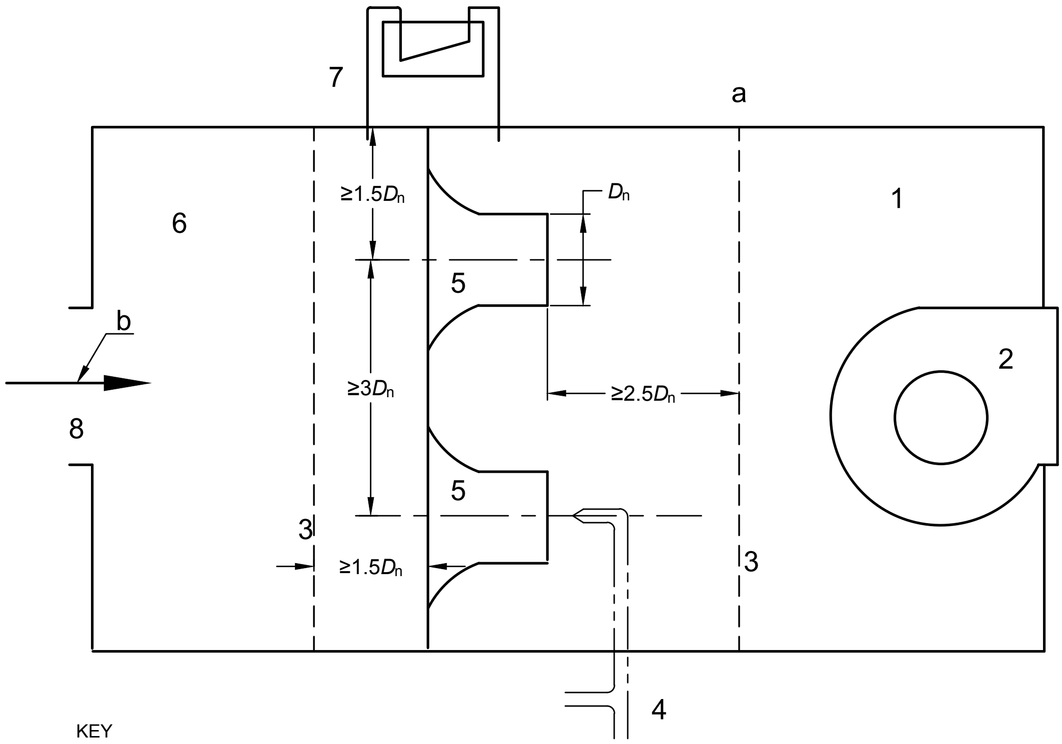
Option 1 — Consisting of a receiving chamber and a discharge chamber separated by a partition in which one or more nozzles are located (*see* Fig. 8)

Option 2 — Receiving chamber and discharge chamber can be made as separate chambers where nozzles are part of discharge chamber.

Air from the equipment under test is conveyed via a duct to the receiving chamber, passes through the nozzle(s) in discharge chamber and is then exhausted to the test room or channelled back to the equipment's inlet.

C-2.2 Diffusers

Option 1 — Installed in the receiving chamber (at a distance at least 1.5 times the largest nozzle throat diameter, D_n) upstream of the partition wall and in the discharge chamber (at a distance at least 2.5 times the



KEY

1 - DISCHARGE CHAMBER
2 - EXHAUST FAN
3 - DIFFUSION BAFFLE
4 - PITOT TUBE (OPTIONAL)
5 - NOZZLE
6 - RECEIVING CHAMBER
7 - APPARATUS FOR DIFFERENTIAL PRESSURE MEASUREMENT
8 - ADAPTER DUCT

a - Diffusion baffles should have uniform perforations, with approximately 40 percent of free area.

b - Airflow.

FIG. 8 AIR FLOW MEASURING APPARATUS

largest nozzle throat diameter, D_n) downstream of the exit plane of the largest nozzle.

Option 2 — Installed in the discharge chamber (at a distance at least 1.5 times the largest nozzle throat diameter, D_n) upstream of the inlet plane of the largest nozzle and (at a distance at least 2.5 times the largest nozzle throat diameter, D_n) downstream of the exit plane of the largest nozzle.

C-2.3 Exhaust Fan

Capable of providing the desired static pressure at the equipment's outlet, installed in one wall of the discharge chamber and provided with a means of varying its capacity.

C-2.4 Manometers / Differential Pressure Gauge

For measuring the static pressure drop across the nozzle(s).

Option 1— One end of the manometer should be connected to a static pressure tap located flush with the inner wall of the receiving chamber and the other end to a static pressure tap located flush with the inner wall of the discharge chamber, or preferably, several taps in each chamber should be connected to several manometers in parallel or manifolded to a single manometer. Static pressure connections should be located so as not to be affected by airflow.

Option 2 — One end of the manometer should be connected to a static pressure tap located flush with the inner wall of the discharge chamber (inlet plane of the nozzles) and the other end to a static pressure tap located flush with the inner wall of the discharge chamber (exit plane of the nozzles), or preferably, several taps in each chamber should be connected to several manometers in parallel or manifolded to a single manometer. Static pressure connections should be located so as not to be affected by airflow.

C-2.5 Means of Determining the Air Velocity at the Nozzle Throat.

C-2.5.1 The throat velocity of any nozzle in use should be not less than 15 m/s or more than 35 m/s.

C-2.5.2 Nozzles should be constructed in accordance with Fig. 9 and applied in accordance with the provisions of **C-2.5.3** and **C-2.5.4**.

C-2.5.3 The nozzle discharge coefficient, C_d, for the construction shown in Fig. 9, which has a throat length to throat diameter ratio of 0.6, may be determined using equation 3:

$$C_d = 0.9986 - \frac{7.006}{\sqrt{R_e}} + \frac{134.6}{R_e} \quad \ldots 3$$

for Reynolds numbers, R_e, of 12 000 and above.

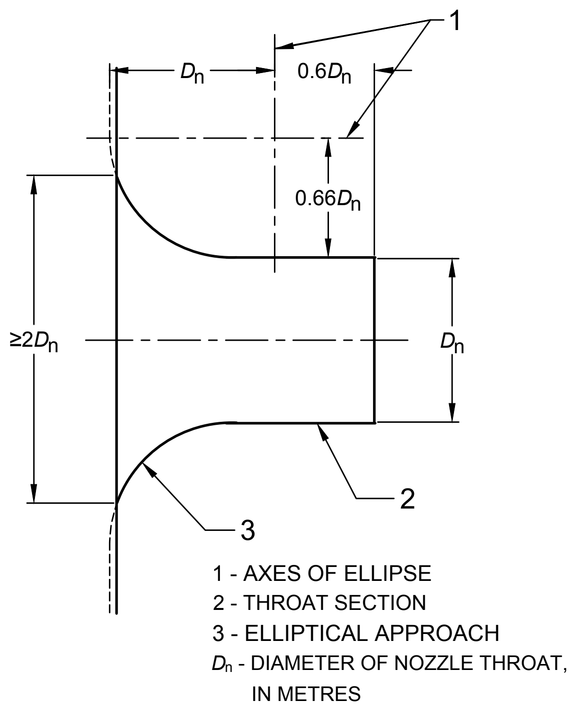


FIG. 9 AIR FLOW MEASURING NOZZLES

The Reynolds number is defined as equation 4

$$R_e = \frac{V_a D_n}{V} \quad \ldots 4$$

where,

V_a is the mean airflow velocity at the throat of the nozzle;

D_n is the diameter of the throat of the nozzle; and

V is the kinematic viscosity of air.

C-2.5.4 Nozzles may also be constructed in accordance with appropriate national standards, provided they can be used in the apparatus described in Fig. 8 and result in equivalent accuracy.

C-3 STATIC PRESSURE MEASUREMETS

C-3.1 The pressure taps should consist of (6.25 ± 0.25) mm diameter nipples soldered to the outer plenum surfaces and centred over 1 mm diameter holes through the plenum. The edges of these holes should be free of burrs and other surface irregularities.

C-3.2 The plenum and duct section should be sealed to prevent air leakage, particularly at the connections to the equipment and the air measuring device, and should be insulated to prevent heat leakage between the equipment outlet and the temperature measuring instruments.

C-4 DISCHARGE AIRFLOW MEASUREMENTS

C-4.1 The outlet or outlets of the equipment under test should be connected to the receiving chamber by adaptor ducting of negligible air resistance, as shown in Fig. 8.

C-4.2 To establish zero static pressure with respect to the test room at the discharge of the air conditioner or heat pump in the receiving chamber, a manometer should have one side connected to one or more static pressure connections located flush with the inner wall of the receiving chamber.

C-5 INDOOR-SIDE AIRFLOW MEASUREMENTS

C-5.1 The following readings should be taken:

a) Barometric pressure;

b) Nozzle dry-bulb and wet-bulb temperatures or dew point temperatures; and

c) Static pressure difference at the nozzle(s) or optionally, nozzle velocity pressure.

C-5.2 Air mass flow rate, q_m, through a single nozzle is determined using equation 5:

$$q_m = Y \times C_d \times A_n \sqrt{\frac{2p_v}{V'_n}} \qquad \ldots 5$$

Where, A_n is the area of the nozzle throat, in square metres (m^2).

The expansion factor, Y, is obtained from equation 6:

$$Y = 0.452 + 0.548\,\alpha \qquad \ldots 6$$

The pressure ratio, α, is obtained from equation 7:

$$a = 1 - \frac{p_v}{p_n} \qquad \ldots 7$$

Air volume flow rate, q_v, through a single nozzle is determined using equation 8

$$q_v = Y \times C_d \times A_n \sqrt{2_p V'_n} \qquad \ldots 8$$

Where V'_n is calculated using equation 9

$$V'_n = \frac{v_n}{1+W_n} \qquad \ldots 9$$

And W_n is the specific humidity at the nozzle inlet.

Air volume flow rate expressed in terms of standard air q_s is calculated by equation 10

$$q_s = \frac{q_v}{1.204 v'_n} \qquad \ldots 10$$

C-5.3 Airflow through multiple nozzles may be calculated in accordance with **C-5.2**, except that the total flow rate is then the sum of the q_m or q_v values for each nozzle used.

ANNEX D

(*Clauses* 9.1.1.3, 9.1.8.2, 10.1.1 *and* 10.1.2)

CALORIMETER TEST METHOD

D-1 GENERAL

D-1.1 The calorimeter provides a method for determining capacity simultaneously on both the indoor-side and the outdoor-side. In the cooling mode, the indoor-side capacity determination should be made by balancing the cooling and dehumidifying effects with measured heat and water inputs. The outdoor-side capacity provides a confirmative test of the cooling and dehumidifying effects by balancing the heat and water rejection on the condenser side with a measured amount of cooling.

D-1.2 The two calorimeter test chambers, indoor-side and outdoor-side, are separated by an insulated partition having an opening into which the non-ducted, single-packaged unitary equipment is mounted.

The indoor unit of split unit is mounted on the frame away from the partition wall and at a suitable height. The outdoor unit of the split system is kept on table or trolley of height > 0.4m above the chamber floor. The distance around the indoor and outdoor unit shall be as per manufacturer instructions.

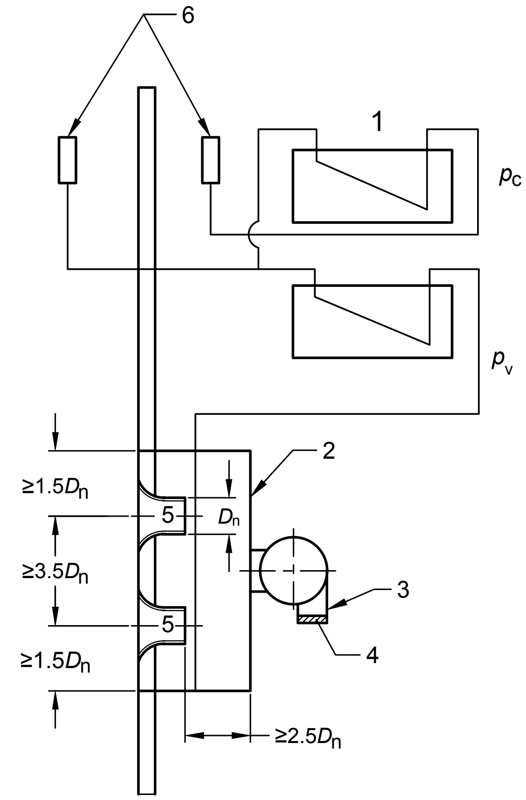
The equipment should be installed in a manner similar to a normal installation. No effort should be made to seal the internal construction of the equipment to prevent air leakage from the condenser side to the evaporator side or vice versa. No connections or alterations should be made to the equipment which might in any way alter its normal operation.

D-1.3 A pressure-equalizing device, as illustrated in Fig. 10, should be provided in the partition wall between the indoor-side and the outdoor-side test chambers to maintain a balanced pressure between these test chambers and also to permit measurement of leakage, exhaust and ventilation air. This device consists of one or more nozzles of the type shown in Fig. 9, a discharge chamber equipped with an exhaust fan and manometers for measuring test chamber and airflow pressures.

Since the airflow from one test chamber to the other may be in either direction, two such devices mounted in opposite directions or a reversible device should be used. The manometer pressure pickup tubes should be located so as to be unaffected by air discharged from the equipment or by the exhaust from the pressure-equalizing device. The fan or blower, which exhausts air from the discharge chamber, should permit variation of its airflow by any suitable means, such as a variable speed drive or a damper as shown in Fig. 10. The exhaust from this fan or blower should be such that it does not affect the inlet air to the equipment.

The pressure equalizing device should be adjusted during calorimeter tests or airflow measurements so that the static pressure difference between the indoor-side and outdoor-side test chambers is not greater than 1.25 Pa.

D-1.4 The size of the calorimeter should be sufficient to avoid any restriction to the intake or discharge openings of the equipment. Perforated plates or other suitable grilles should be provided at the discharge opening from the reconditioning equipment to avoid face velocities exceeding 0.5 m/s. Sufficient space should be allowed in front of any inlet or discharge grilles of the equipment to avoid interference with the airflow. Minimum distance from the equipment to side walls or ceiling of the test chamber(s) should be 1 m, except for the back of console-type equipment, which should be in normal relation to the wall. Ceiling mounted equipment should be installed at a minimum distance of 1.8 m from the floor.



1 - PRESSURE MANOMETERS
2 - DISCHARGE CHAMBER
3 - EXHAUST FAN
4 - DAMPER
5 - NOZZLE
6 - PICKUP TUBE

p_c - TEST CHAMBER EQUALIZATION PRESSURE
p_v - NOZZLE VELOCITY PRESSURE
D_n - NOZZLE THROAT DIAMETER, IN METRES

FIG. 10 PRESSURE-EQUALIZING DEVICE

Table 7 gives the suggested dimensions for the calorimeter. To accommodate peculiar sizes of equipment, it may be necessary to alter the suggested dimensions to comply with the space requirements.

D-1.5 Each test chamber should be provided with reconditioning equipment to maintain specified airflow and prescribed conditions. Reconditioning apparatus for the indoor-side test chamber should consist of heaters to supply sensible heat and a humidifier to supply moisture. Reconditioning apparatus for the outdoor-side test chamber should provide cooling, dehumidification and humidification. The energy supply should be controlled and measured.

D-1.6 When calorimeters are used for heat pumps, they should have heating, humidifying and cooling capabilities for both rooms (*see* Fig. 11 and 12) or other means, such as rotating the equipment, may be used as long as the rating conditions are maintained.

D-1.7 Reconditioning apparatus for both test chambers should be provided with fans of sufficient capacity to ensure airflows of not less than twice the quantity of air discharged by the equipment under test in the calorimeter. The calorimeter should be equipped with means of measuring or determining specified wet- and dry-bulb temperatures in both calorimeter test chambers.

D-1.8 It is recognized that in both the indoor-side and outdoor-side test chambers, temperature gradients and airflow patterns result from the interaction of the reconditioning apparatus and test equipment. Therefore, the resultant conditions are peculiar to and dependent on

Table 7 Sizes of Calorimeter

(*Clause* D-1.4)

Sl No.	Rated Cooling Capacity of Equipment[1] (W)	Suggested Minimum Inside Dimensions of Each Room of the Calorimeter (m) Width	Height	Length
(1)	(2)	(3)	(4)	(5)
i)	3 000	2.4	2.1	1.8
ii)	6 000	2.4	2.1	2.4
iii)	9 000	2.7	2.4	3.0
iv)	12 000[2]	3.0	2.4	3.7

[1] All figures are round numbers.
[2] Larger capacity equipment requires larger calorimeters.

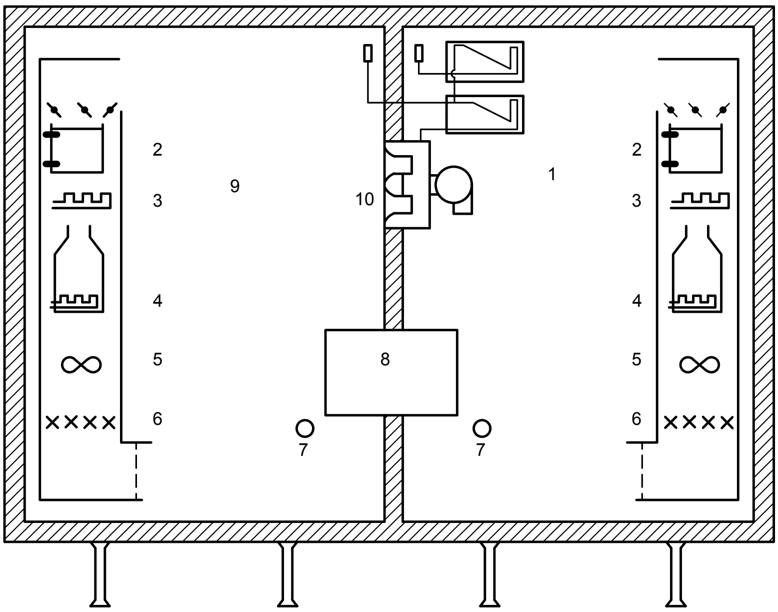
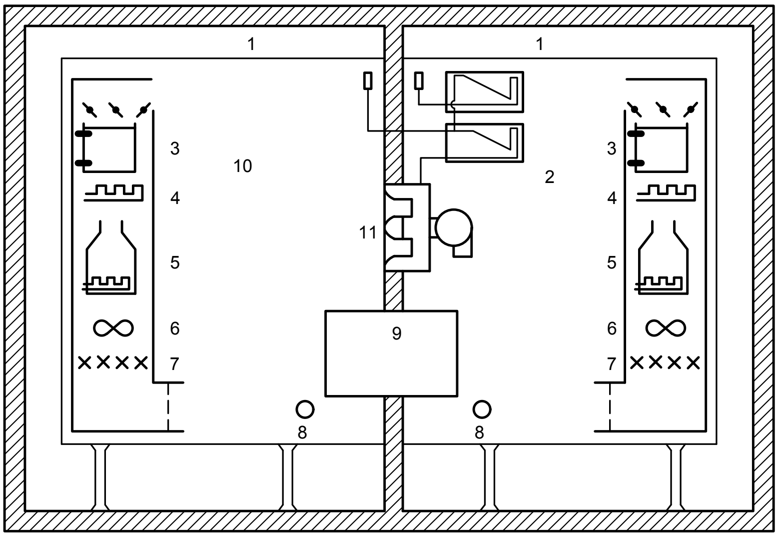


Fig. 11 Typical Calibrated Room-Type Calorimeter



1 - CONTROLLER-TEMPERATURE AIR SPACE
2 - OUTDOOR-SIDE TEST CHAMBER
3 - COOLING COIL
4 - HEATING COIL
5 - HUMIDIFIER
6 - FAN
7 - MIXER
8 - AIR SAMPLING TUBE
9 - EQUIPMENT UNDER TEST
10 - INDOOR-SIDE TEST CHAMBER
11 - PRESSURE EQUALIZATION DEVICE

FIG. 12 TYPICAL BALANCED AMBIENT ROOM-TYPE CALORIMETER

a given combination of test chamber size, arrangement and size of reconditioning apparatus and the air discharge characteristics of the equipment under test.

The point of measurement of specified test temperatures, both wet and dry-bulb, should be such that the following conditions are fulfilled:

a) The measured temperatures should be representative of the temperature surrounding the equipment and should simulate the conditions encountered in an actual application for both indoor and outdoor-sides, as indicated above.
b) At the point of measurement, the temperature of air should not be affected by air discharged from any piece of the equipment. This makes it mandatory that the temperatures are measured upstream of any re-circulation produced by the equipment.
c) Air sampling tubes should be positioned on the intake side of the equipment under test.

D-1.9 During a heating capacity test, the temperature of the air leaving the indoor-side of the heat pump shall be monitored to determine if its heating performance is being affected by a build-up of ice on the outdoor-side heat exchanger. A single temperature measuring device, placed at the centre of the indoor air outlet, is sufficient to indicate any change in the indoor air discharge temperature caused by a build-up of ice on the outdoor-side heat exchanger.

D-1.10 Interior surfaces of the calorimeter test chambers should be of non-porous material with all joints sealed against air and moisture leakage. The access door should be tightly sealed against air and moisture leakage by use of gaskets or other suitable means.

D-1.11 If defrost controls on the heat pump provide for stopping the indoor airflow, provisions shall be made to stop the test apparatus airflow to the equipment on both the indoor and outdoor-sides during such a defrost period. If it is desirable to maintain operation of the reconditioning apparatus during the defrost period, provisions may be made to bypass the conditioned air around the equipment as long as assurance is provided that the conditioned air does not aid in the defrosting. A watt-hour meter shall be used for obtaining the integrated electrical input to the equipment under test.

D-2 CALIBRATED ROOM-TYPE CALOREMETER

D-2.1 Heat leakage may be determined in either the indoor-side or outdoor-side test chamber by the following method: All openings should be closed. Either test chamber may be heated by electric heaters to a temperature of at least 11 °C above the surrounding ambient temperature. The ambient temperature should be maintained constant within ±1 K outside all six enveloping surfaces of the test chamber, including the separating partition. If the construction of the partition is identical to that of the other walls, the heat leakage through the partition may be determined on a proportional area basis.

D-2.2 For calibrating the heat leakage through the separating partition alone, the following procedure may be used: a test is carried out as described above. Then the temperature of the adjoining area on the other side of the separating partition is raised to equal the temperature in the heated test chamber, thus eliminating heat leakage through the partition, while the 11°C differential is

maintained between the heated test chamber and the ambient surrounding the other five enveloping surfaces.

The difference in heat input between the first test and the second test permits determination of the leakage through the partition alone.

D-2.3 For the outdoor-side test chamber equipped with means of cooling, an alternative means of calibration may be to cool the test chamber to a temperature of at least 11°C below the ambient temperature (on six sides) and carry out a similar analysis.

D-2.4 The indoor-side calorimeter including the central partition and the outdoor-side calorimeter shall be insulated so that heat leakage (including radiation) does not exceed 5 percent of the equipment capacity. Space where enough air circulation is available shall be secured under the floor of the room-type calorimeter.

D-3 BALANCED AMBIENT ROOM-TYPE CALORIMETER

D-3.1 The balanced ambient room-type calorimeter is shown in Fig. 12 and is based on the principle of maintaining the dry-bulb temperatures surrounding the particular test chamber equal to the dry-bulb temperatures maintained within that test chamber. If the ambient wet-bulb temperature is also maintained equal to that within the test chamber, the vapour-proofing provisions of **D-1.10** are not required.

D-3.2 The floor, ceiling and walls of the calorimeter test chambers shall be spaced a sufficient distance away from the floor, ceiling and walls of the controlled areas in which the test chambers are located in order to provide a uniform air temperature in the intervening space. It is recommended that this distance be at least 0.3 m. Means shall be provided to circulate the air within the surrounding space to prevent stratification.

D-3.3 Heat leakage through the separating partition shall be introduced into the heat balance calculation and may be calibrated in accordance with **D-2.2** or may be calculated.

D.3.4 It is recommended that the floor, ceiling and walls of the calorimeter test chambers be insulated so as to limit heat leakage (including radiation) to no more than 10 percent of the test equipment's capacity, with an 11°C temperature difference, or 300 W for the same temperature difference, whichever is the greater, as tested using the procedure given in **D-2.2**.

D-4 CALIBRATION OF COOLING CAPACITY

D-4.1 The energy flow quantities used to calculate the total cooling capacity, based on indoor-side and outdoor-side measurements, are shown in Fig. 13.

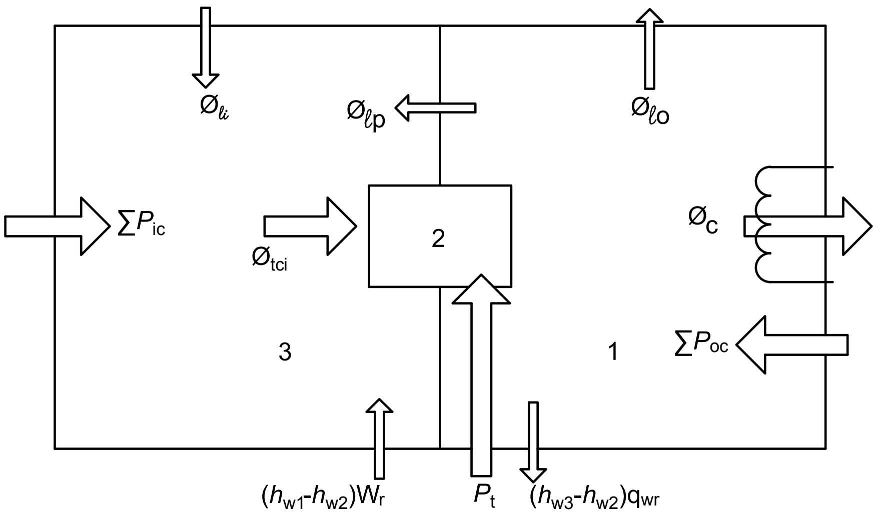
D-4.2 The total cooling capacity on the indoor-side, ϕ_{tci}, as tested in either the calibrated or balanced ambient, room-type calorimeter, is calculated using equation 11:

$$\varnothing_{\mathrm{tci}} = \sum P_{\mathrm{ic}} + (h_{\mathrm{w1}} - h_{\mathrm{w2}})W_{\mathrm{r}} + \varnothing_{\mathrm{lp}} + \varnothing_{\mathrm{li}} \quad \ldots 11$$

NOTE — If no water is introduced during the test, h_{w1} is taken at the temperature of the water in the humidifier tank of the conditioning apparatus.

When a cooling coil of the indoor-side calorimeter is used for testing of small capacity units, in order to stabilize the test condition, equation 12 shall be used. ϕ_{ci} in equation 12 is the amount of heat exchanged in the cooling coil of the indoor-side calorimeter.

$$\varnothing_{\mathrm{tci}} = \sum P_{\mathrm{ic}} + (h_{\mathrm{w1}} - h_{\mathrm{w2}})W_{\mathrm{r}} + \varnothing_{\mathrm{lp}} + \varnothing_{\mathrm{li}} - \varnothing_{\mathrm{ci}} \quad \ldots 12$$



1 - OUTDOOR-SIDE TEST CHAMBER
2 - EQUIPMENT UNDER TEST
3 - INDOOR-SIDE TEST CHAMBER

FIG. 13 CALORIMETER ENERGY FLOWS DURING COOLING CAPACITY TESTS

D-4.3 When it is not practical to measure the temperature of the air leaving the indoor-side test chamber to the outdoor-side test chamber, the temperature of the condensate may be assumed to be at the measured or estimated wet-bulb temperature of the air leaving the test equipment.

D-4.4 The water vapour condensed by the equipment under test, W_r, may be determined by the amount of water evaporated into the indoor-side test chamber by the reconditioning equipment to maintain the required humidity.

D-4.5 Heat leakage, ϕ_{lp}, into the indoor-side test chamber through the separating partition between the indoor-side and outdoor-side test chambers may be determined from the calibrating test or, in the case of the balanced-ambient room-type test chamber, may be based on calculations.

D-4.6 The total cooling capacity on the outdoor-side, ϕ_{tco}, as tested in either the calibrated or balanced-ambient, room-type calorimeter is calculated using equation 13:

$$\emptyset_{tco} = \emptyset_c - \sum P_{oc} - P_t + (h_{w3} - h_{w2})W_r + \emptyset_{lp} + \emptyset_{lo} \quad \ldots 13$$

NOTE — The h_{w3} enthalpy is taken at the temperature at which the condensate leaves the outdoor-side test chamber of the reconditioning apparatus.

D-4.7 The heat leakage rate into the indoor-side test chamber through the separating partition between the indoor-side and outdoor-side test chambers, ϕ_{lp}, may be determined from the calibrating test or, in the case of the balanced-ambient room-type test chamber, may be based on calculations.

NOTE — This quantity is numerically equal to that used in equation 11 if, and only if, the area of the separating partition exposed to the outdoor-side is equal to the area exposed to the indoor-side test chamber.

D-4.8 The latent cooling capacity (room dehumidifying capacity), ϕ_d, is calculated using equation 14:

$$\emptyset_{\mathbf{d}} = K_1 W_r \quad \ldots 14$$

D-4.9 The sensible cooling capacity, ϕ_{sci}, is calculated using equation 15

$$\emptyset_{\mathbf{sci}} = \emptyset_{\mathbf{tci}} - \emptyset_{\mathbf{d}} \quad \ldots 15$$

D-4.10 Sensible heat ratio (SHR) is calculated using equation 16

$$\mathrm{SHR} = \emptyset_{\mathbf{sci}} / \emptyset_{\mathbf{tci}} \quad \ldots 16$$

D-5 CALCULATION OF HEATING CAPACITY

D-5.1 The energy flow quantities used to calculate the total heating capacity, based on indoor-side and outdoor-side measurements, are shown in Fig. 14.

D-5.2 Determination of the heating capacity by measurement in the indoor-side test chamber of the calorimeter, ϕ_{hi}, is calculated using equation 17.

$$\emptyset_{\mathbf{hi}} = \emptyset_{\mathbf{ci}} - \sum P_{ic} - \emptyset_{\mathbf{lp}} - \emptyset_{\mathbf{li}} \quad \ldots 17$$

NOTE — ΣP_{ic} is the other power input to the indoor-side test chamber (for example, illumination, electrical and thermal power input to the compensating device, heat balance of the humidification device), in watts.

D-5.3 Determination of the heating capacity by measurement of the heat absorbing side, ϕ_{ho}, is calculated for equipment where the evaporator takes the heat from an airflow using equation 18

$$\emptyset_{\mathbf{ho}} = \sum P_{oc} + P_t + (h_{w4} - h_{w5})q_{wo} - q_{lp} - \emptyset_{\mathbf{lo}} \quad \ldots 18$$

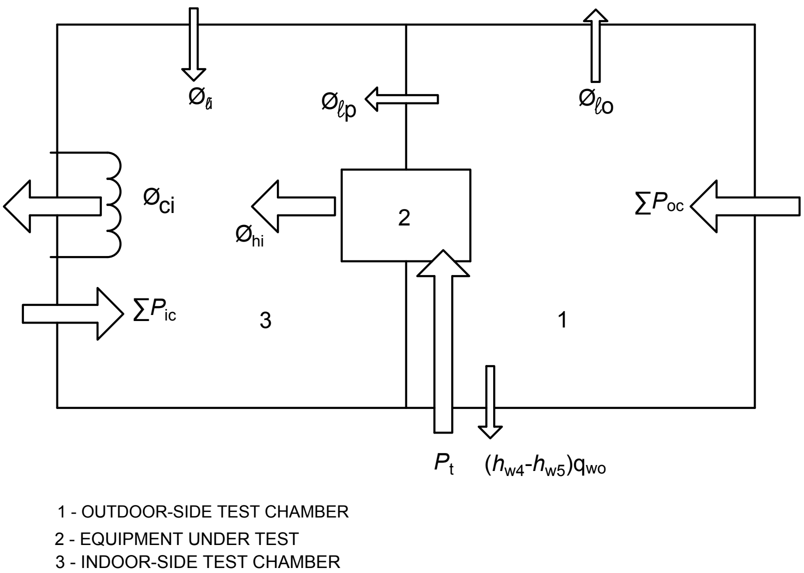


FIG. 14 CALORIMETER ENERGY FLOWS DURING HEATING CAPACITY TESTS

ANNEX E

(*Clauses* 9.1.8.2, 10.1.1 *and* 10.1.3)

INDOOR AIR ENTHALPY TEST METHOD

E-1 GENERAL

In the air enthalpy test method, capacities are determined from measurements of entering and leaving wet and dry-bulb temperatures and the associated airflow rate.

E-2 APPLICATION

E-2.1 Air leaving the equipment under the test shall lead directly to the discharge chamber. If a direct connection cannot be made between the equipment and the discharge chamber, a short plenum shall be attached to the equipment. In this case, the short plenum shall have the same size as the discharge opening of the equipment or shall be constructed so as not to prevent the leaving air from expanding. The cross-section area of the airflow channel through the discharge chamber shall be such that the average air velocity is less than 1.25 m/s against the airflow rate of the equipment under test. The static pressure difference between the discharge chamber and intake opening of the equipment under test shall be zero.

E-2.2 Airflow measurements shall be made in accordance with the provisions specified in Annex C.

E-3 CALCULATION OF COOLING CAPACITY

The total cooling capacity based on the indoor-side test data, ϕ_{tci}, shall be calculated using equation 19

$$\emptyset_{\mathbf{tci}} = \frac{q_{\mathbf{vi}}(h_{\mathbf{a1}} - h_{\mathbf{a2}})}{v_{\mathbf{n}}} = \frac{q_{\mathbf{vi}}(h_{\mathbf{a1}} - h_{\mathbf{a2}})}{v'_{\mathbf{n}}(1 + W_{\mathbf{n}})} \quad \ldots 19$$

The sensible cooling capacity based on the indoor-side test data, ϕ_{sci}, shall be calculated using equation 20

$$\emptyset_{\mathbf{sci}} = \frac{q_{\mathbf{vi}}(c_{\mathbf{pa1}}t_{\mathbf{a1}} - c_{\mathbf{pa2}}t_{\mathbf{a2}})}{v_{\mathbf{n}}} = \frac{q_{\mathbf{vi}}(c_{\mathbf{pa1}}t_{\mathbf{a1}} - c_{\mathbf{pa2}}t_{\mathbf{a2}})}{v'_{\mathbf{n}}(1 + W_{\mathbf{n}})} \quad \ldots 20$$

The latent cooling capacity based on the indoor-side test data, ϕ_{d}, shall be calculated using equation 21 and 22:

$$\emptyset_{\mathbf{d}} = \frac{K_1 q_{\mathbf{vi}}(W_{\mathbf{i1}} - W_{\mathbf{i2}})}{v_{\mathbf{n}}} = \frac{K_1 q_{\mathbf{vi}}(W_{\mathbf{i1}} - W_{\mathbf{i2}})}{v'_{\mathbf{n}}(1 + W_{\mathbf{n}})} \quad \ldots 21$$

$$\emptyset_{\mathbf{d}} = \emptyset_{\mathbf{tci}} - \emptyset_{\mathbf{sci}} \quad \ldots 22$$

E-4 CALCULATION OF HEATING CAPACITY

Total heating capacity based on indoor-side data, ϕ_{thi}, shall be calculated using equation 23:

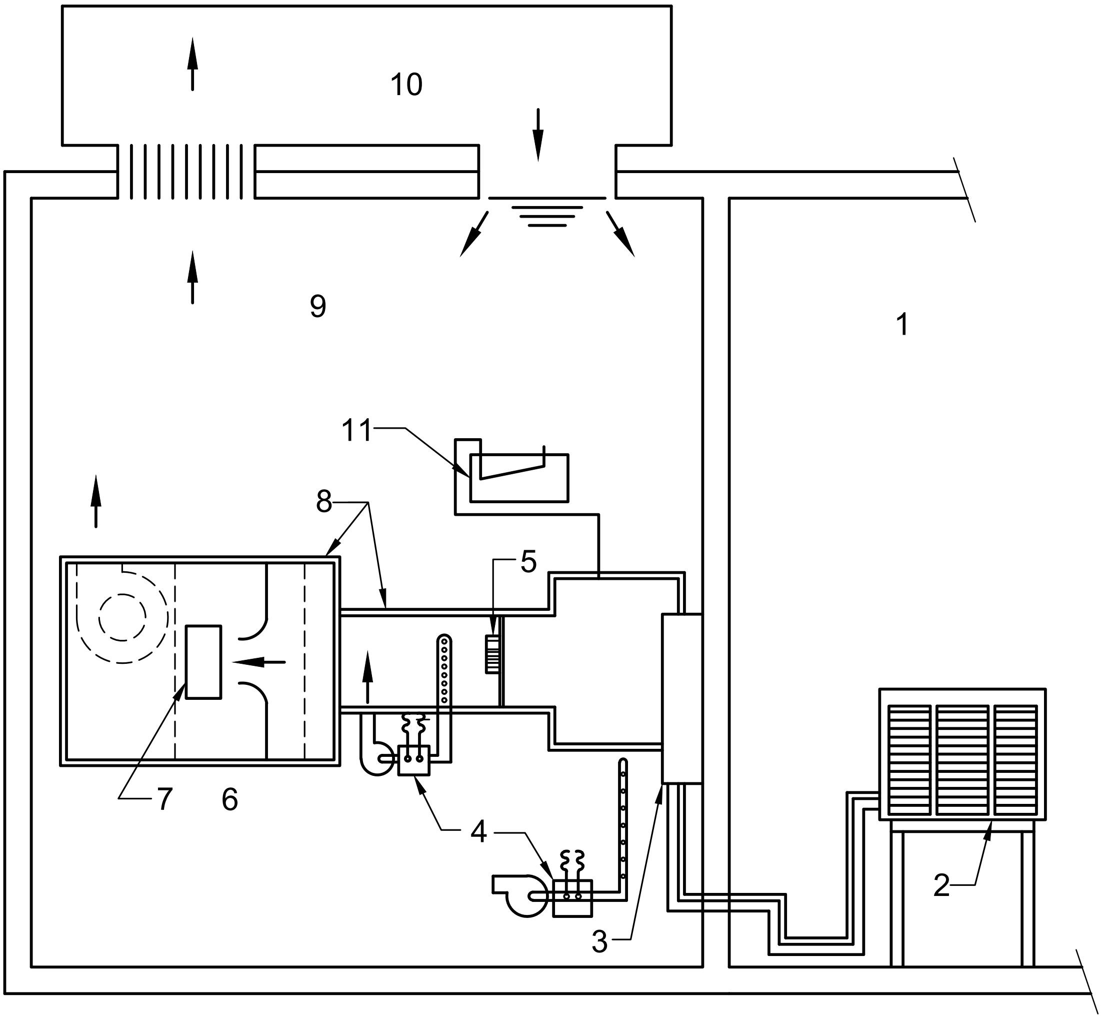
$$\emptyset_{\mathbf{thi}} = \frac{q_{\mathbf{vi}}(c_{\mathbf{pa2}}t_{\mathbf{a2}} - c_{\mathbf{pa1}}t_{\mathbf{a1}})}{v_{\mathbf{n}}} = \frac{q_{\mathbf{vi}}(c_{\mathbf{pa2}}t_{\mathbf{a2}} - c_{\mathbf{pa1}}t_{\mathbf{a1}})}{v'_{\mathbf{n}}(1 + W_{\mathbf{n}})} \quad \ldots 23$$

NOTE — C_{pa1} can be equal to C_{pa2}.

E-5 AIRFLOW ENTHALPY MEASUREMENTS

E-5.1 Tunnel Air Enthalpy Method

The equipment to be tested is typically located in a test room or rooms. An air measuring device is attached to the equipment air discharge (indoor). This device discharges directly into the test room or space, which is provided with suitable means for maintaining the air entering the equipment at the desired wet- and dry-bulb temperatures (*see* Fig. 15). Suitable means for measuring the wet- and dry-bulb temperatures of the air entering and leaving the equipment and the external resistance shall be provided.



1 - OUTDOOR-SIDE TEST ROOM
2 - OUTDOOR UNIT OF EQUIPMENT UNDER TEST
3 - INDOOR-SIDE COIL SECTION OF EQUIPMENT UNDER TEST
4 - AIR TEMPERATURE AND HUMIDITY MEASURING INSTRUMENTS
5 - MIXER
6 - AIRFLOW MEASURING APPARATUS
7 - DOOR/WINDOW
8 - INSULATION
9 - INDOOR-SIDE TEST ROOM
10 - ROOM CONDITIONING APPARATUS
11 - APPARATUS FOR DIFFERENTIAL PRESSURE MEASUREMENT

FIG. 15 TUNNEL AIR ENTHALPY TEST METHOD ARRANGEMENT

ANNEX F

(*Clauses* 7.2 *and* 8.2)

ISEER CALCULATIONS

F-1 COOLING SEASONAL PERFORMANCE FACTOR (CSPF)

The cooling seasonal performance factor (CSPF), F_{CSP}, of the equipment shall be calculated by equation 24.

$$F_{CSP} = \frac{L_{CST}}{C_{CSE}} \quad \ldots 24$$

F-2 DEFINED COOLING LOAD

The defined cooling load shall be represented by a value and the assumption that it is linearly changing depending on the change in outdoor temperature.

Defined cooling load which shall be used is shown in Table 8.

Table 8 Defined Cooling Load

(*Clause* **F-2**)

Sl No.	Parameter	Load Zero (0)	Load 100 Percent
(1)	(2)	(3)	(4)
i)	Cooling load (W)	0	$\phi_{ful}(t_{100})$
ii)	Temperature (°C)	t_0	t_{100}

Where, t_{100} is the outdoor temperature at 100 percent load and t_0 is the outdoor temperature at 0 percent load.

Reference values of defined cooling load to be used shall be as follows:

$$t_0 = 23\ °C \text{ and } t_{100} = 35\ °C$$

Defined cooling load $L_c(t_j)$ at outdoor temperature t_j, which is necessary to calculate the cooling seasonal energy consumption, shall be determined by equation 25

$$L_c(t_j) = \phi_{ful}(t_{100}) \times \frac{t_j - t_0}{t_{100} - t_0} \quad \ldots 25$$

Where, $\phi_{ful}(t_{100})$ is the cooling capacity at t_{100} at full-load operating conditions.

F-3 OUTDOOR TEMPERATURE BIN DISTRIBUTION FOR COOLING

Cooling seasonal performance factor (CSPF) shall be calculated at the reference climate condition in Table 9.

The calculation of cooling seasonal performance factor may also be done for other climate conditions.

Table 9 shows the reference outdoor temperature bin distribution.

Bin hours of each outdoor temperature may be calculated by multiplying the fractional bin hours by the total annual cooling hours if the fractional bin hours are applicable.

F-4 COOLONG SEASONAL CHARACTERISTICS OF FIXED CAPACITY UNITS

Operational performance at each test, which is used for calculation of seasonal performance factor, shall be in accordance with **7.2** Table 2.

F-4.1 Capacity Characteristics against Outdoor Temperature

Capacity $\phi_{ful}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j linearly changes depending on outdoor temperatures as shown in Fig. 16, and it is determined by equation 26 from two characteristics, one at 35 °C and the other at 29 °C.

$$\phi_{ful}(t_j) = \phi_{ful}(35) + \frac{\phi_{ful}(29) - \phi_{ful}(35)}{35 - 29} \times (35 - t_j) \quad \ldots 26$$

F-4.2 Power Input Characteristics Against Outdoor Temperature

Power input $P_{ful}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j linearly changes depending on outdoor temperatures as shown

Table 9 Reference Outdoor Temperature Bin Distribution

(*Clause* F-3)

Bin number j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Outdoor temperature t_j°C	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	—
Average Annual Hours	527	590	639	660	603	543	451	377	309	240	196	165	130	101	79	59	44	31	20	10	5 774
Fractional bin hours	9.1	10.2	11.1	11.4	10.4	9.4	7.8	6.5	5.4	4.2	3.4	2.9	2.3	1.7	1.4	1	0.8	0.5	0.3	0.2	100
Bin hours n_j	n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	n_{10}	n_{11}	n_{12}	n_{13}	n_{14}	n_{15}	n_{16}	n_{17}	n_{18}	n_{19}	n_{20}	—
Reference bin hours (n_j) h	174	195	211	218	199	179	149	124	102	79	65	54	43	32	26	18	14	9	6	3	1 900

in Fig. 16, and it is determined by equation 27 from two characteristics, one at 35 °C and the other at 29 °C.

$$P_{\mathrm{ful}}(t_j) = P_{\mathrm{ful}}(35) + \frac{P_{\mathrm{ful}}(29) - P_{\mathrm{ful}}(35)}{35-29} \times (35 - t_j) \quad \ldots 27$$

F-4.3 Calculation of Cooling Seasonal Total Load (CSTL)

Cooling seasonal total load (CSTL), L_{CST}, shall be determined using equation 28 from the total sum of cooling load at each outdoor temperature t_j multiplied by bin hours n_j.

$$L_{CST} = \sum_{j=1}^{m} L_c(t_j) \times n_j + \sum_{j=m+1}^{n} \phi_{\mathrm{ful}}(t_j) \times n_j \quad \ldots 28$$

a) In the range of $L_c(t_j) \leq \phi_{\mathrm{ful}}(t_j)$ (j = 1 to m):

$L_c(t_j)$ shall be calculated by equation 25.

b) In the range of $L_c(t_j) > \phi_{\mathrm{ful}}(t_j)$ (j = m+1 to n):

$\phi_{\mathrm{ful}}(t_j)$ shall be calculated by equation 26.

F-4.4 Calculation of Cooling Seasonal Energy Consumption (CSEC)

Cooling seasonal energy consumption (CSEC), C_{CSE}, shall be determined using equation 29 from the total sum of cooling energy consumption at each outdoor temperature t_j.

$$C_{CSE} = \sum_{j=1}^{n} X(t_j) \times P_{\mathrm{ful}}(t_j) \times \frac{n_j}{F_{PL}(t_j)} \quad \ldots 29$$

Operation factor $X(t_j)$ shall be calculated by equation 30.

$$X(t_j) = \frac{L_c(t_j)}{\phi(t_j)} \quad \ldots 30$$

In the case of $L_c(t_j) > \phi(t_j)$, $X(t_j) = 1$.

Part load factor (PLF), $F_{PL}(t_j)$ caused by the equipment when it is cyclically operated at outdoor temperature t_j, shall be determined by equation 31 using degradation coefficient C_D.

$$F_{PL}(t_j) = 1 - C_D(1 - X(t_j)) \quad \ldots 31$$

a) Cyclic operation ($L_c(t_j) \leq \phi_{\mathrm{fu}}l(t_j)$):

In equation 29, $X(t_j)$ shall be calculated by equation 30.

In equation 30, $\phi(t_j) = \phi_{\mathrm{ful}}(t_j)$.

b) Full capacity operation ($L_c(t_j) > \phi_{\mathrm{ful}}(t_j)$):

In equation 29 $X(t_j) = F_{PL}(t_j) = 1$.

F-5 COOLING SEASONAL CHARACTERISTICS OF TWO-STAGE CAPACITY UNITS

Coefficients specified in Table 9 may be used for each characteristic.

F-5.1 Capacity Characteristics Against Outdoor Temperature

Capacity $\phi_{\mathrm{ful}}(t_j)$ (W) of the equipment when it is operated for cooling full capacity at outdoor temperature t_j shall be defined by equation 26.

Capacity $\phi_{\mathrm{min}}(t_j)$ (W) of the equipment when it is operated for cooling minimum capacity at outdoor temperature t_j shall be defined by equation 32.

$$\phi_{\mathrm{min}}(t_j) = \phi_{\mathrm{min}}(35) + \frac{\phi_{\mathrm{min}}(29) - \phi_{\mathrm{min}}(35)}{35-29} \times (35 - t_j) \ldots 32$$

F-5.2 Power Input Characteristics against Outdoor Temperature

Power input $P_{\mathrm{ful}}(t_j)$ (W) of the equipment when it is operated for cooling full capacity at outdoor temperature t_j shall be defined by equation 27.

Power input $P_{\mathrm{min}}(t_j)$ (W) of the equipment when it is operated for cooling minimum capacity at outdoor temperature t_j shall be defined by equation 33.

$$P_{\mathrm{min}}(t_j) = P_{\mathrm{min}}(35) + \frac{P_{\mathrm{min}}(29) - P_{\mathrm{min}}(35)}{35-29} \times (35 - t_j) \quad \ldots 33$$

F-5.3 Calculation of Cooling Seasonal Total Load (CSTL)

Equation 28 in **F-4.3** shall be used.

F-5.4 Calculation of Cooling Seasonal Energy Consumption (CSEC)

Cooling seasonal energy consumption (CSEC), C_{CSE}, shall be calculated by:

$$C_{CSE} = \sum_{j=1}^{k} \frac{X(t_j) \times P_{\mathrm{min}}(t_j) \times n_j}{F_{PL}(t_j)} + \sum_{j=k+1}^{m} P_{\mathrm{mf}}(t_j) \times n_j + \sum_{j=m+1}^{n} P_{\mathrm{ful}}(t_j) \times n_j \quad \ldots 34$$

Relation of cooling capacity characteristics and power input characteristics to cooling load at outdoor temperature t_j is shown in Fig. 17.

a) First stage cyclic operation ($L_c(t_j) \leq \phi_{\mathrm{min}}(t_j)$, j = 1 to k):

In equation 34, $X(t_j)$ shall be calculated by equation 30.

In equation 30, $\phi(t_j) = \phi_{\mathrm{min}}(t_j)$.

b) Second stage cyclic operation ($\phi_{\mathrm{min}}(t_j) < L_c(t_j) \leq \phi_{\mathrm{ful}}(t_j)$, j = k + 1 to m):

$$P_{\mathrm{mf}}(t_j) = X_{\mathrm{mf}}(t_j) \times P_{\mathrm{min}}(t_j) + (1 - X_{\mathrm{mf}}(t_j)) \times P_{\mathrm{ful}}(t_j) \ldots 35$$

$$X_{\mathrm{mf}}(t_j) = \frac{\phi_{\mathrm{ful}}(t_j) - L_c(t_j)}{\phi_{\mathrm{ful}}(t_j) - \phi_{\mathrm{min}}(t_j)} \quad \ldots 36$$

c) Full capacity operation ($Lc(t_j)$ > $\phi_{ful}(t_j)$, j = m + 1 to n):

$P_{ful}(t_j)$ shall be calculated by equation 27.

F-6 COOLING SEASONAL CHARACTERISTICS OF MULTI-STAGE CAPACITY UNITS

F-6.1 Capacity Characteristics against Outdoor Temperature

Capacities $\phi_{ful}(t_j)$ and $\phi_{min}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j are shown in Fig. 18 and shall be determined by equations 26 and 32 respectively.

Below equation shows cooling half capacity characteristics at outdoor temperature t_j

$$\emptyset_{haf}(t_j) = \emptyset_{haf}(35) + \frac{\emptyset_{haf}(29) - \emptyset_{haf}(35)}{35-29} \times (35 - t_j) \quad \ldots 37$$

F-6.2 Power Input Characteristics against Outdoor Temperature

Power input $P_{ful}(t_j)$ and $P_{min}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j shall be determined by equations 27 and 33, respectively.

Below equation shows cooling half power input at outdoor temperature t_j.

$$P_{haf}(t_j) = P_{haf}(35) + \frac{P_{haf}(29) - P_{haf}(35)}{35-29} \times (35 - t_j) \quad \ldots 38$$

F-6.3 Calculation of Cooling Seasonal Total Load (CSTL)

Equation 28 in **F-4.3** shall be used.

F-6.4 Calculation of Cooling Seasonal Energy Consumption (CSEC)

When the minimum capacity data are available, then the cooling seasonal energy consumption (CSEC), C_{CSE}, shall be calculated by:

$$C_{CSE} = \sum_{j=1}^{k} \frac{X(t_j) \times P_{min}(t_j) \times n_j}{F_{PL}(t_j)} + \sum_{j=k+1}^{p} P_{mh}(t_j) \times n_j + \sum_{j=p+1}^{m} P_{hf}(t_j) \times n_j + \sum_{j=m+1}^{n} P_{ful}(t_j) \times n_j \ldots 39 \quad \ldots 39$$

Relation of cooling capacity and power input characteristics to cooling load at outdoor temperature t_j is shown in Fig. 18.

a) First stage cyclic operation ($L_c(t_j) \leq \phi_{min}(t_j)$, j = 1 to k):

In equation 39, $X(t_j)$ shall be calculated by equation 30

In equation 30 , $\phi(t_j) = \phi_{min}(t_j)$.

b) Second stage cyclic operation ($\phi_{min}(t_j) < L_c(t_j) \leq \phi_{haf}(t_j)$, j = k + 1 to p):

$$P_{mh}(t_j) = X_{mh}(t_j) \times P_{min}(t_j) + (1 - X_{mh}(t_j)) \times P_{haf}(t_j) \quad \ldots 40$$

$$X_{mh}(t_j) = \frac{\emptyset_{haf}(t_j) - L_C(t_j)}{\emptyset_{haf}(t_j) - \emptyset_{min}(t_j)} \quad \ldots 41$$

c) Third stage cyclic operation ($\phi_{haf}(t_j) < L_c(t_j) \leq \phi_{ful}(t_j)$, j = p + 1 to m):

$$P_{hf}(t_j) = X_{hf}(t_j) \times P_{haf}(t_j) + (1 - X_{hf}(t_j)) \times P_{ful}(t_j) \quad \ldots 42$$

$$X_{hf}(t_j) = \frac{\emptyset_{ful}(t_j) - L_C(t_j)}{\emptyset_{ful}(t_j) - \emptyset_{haf}(t_j)} \quad \ldots 43$$

d) Full capacity operation ($L_c(t_j) > \phi_{ful}(t_j)$, j = m + 1 to n):

$P_{ful}(t_j)$ shall be calculated by equation 27.

F-7 COOLING SEASONAL CHARACTERISTICS OF VARIABLE CAPACITY UNITS

Coefficients specified in Table 9 may be used for each characteristic.

F-7.1 Capacity Characteristics against Outdoor Temperature

Capacities $\phi_{ful}(t_j)$, $\phi_{min}(t_j)$ and $\phi_{haf}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j are shown in Fig. 19 and shall be determined by equations 26, 32 and 37, respectively.

F-7.2 Power Input Characteristics against Outdoor Temperature

Power input $P_{ful}(t_j)$, $P_{min}(t_j)$ and $P_{haf}(t_j)$ (W) of the equipment when it is operated for cooling at outdoor temperature t_j shall be determined by equations 27, 33 and 38, respectively.

F-7.3 Calculation of Cooling Seasonal Total Load (CSTL)

Equation 28 in **F-4.3** shall be used.

F-7.4 Calculation of Cooling Seasonal Energy Consumption (CSEC)

When the minimum capacity data are available, then the cooling seasonal energy consumption (CSEC), C_{CSE}, shall be calculated by equation 39.

When the minimum capacity data are not available, then the cooling seasonal energy consumption (CSEC), $C_{CSE,}$ shall be calculated alternatively by

$$C_{CSE} = \sum_{j=1}^{p} \frac{X(t_j) \times P_{haf}(t_j) \times n_j}{F_{PL}(t_j)} + \sum_{j=p+1}^{m} P_{hf}(t_j) \times n_j + \sum_{j=m+1}^{n} P_{ful}(t_j) \times n_j \quad \ldots 44$$

Relation of cooling capacity, power input and EER characteristics to cooling load at outdoor temperature t_j is shown in Fig. 19.

Calculation methods for each term of equation 39 are as follows:

a) Cyclic operation ($L_c(t_j) \leq \phi_{min}(t_j)$, j = 1 to k):

In equation 39, $X(t_j)$ shall be calculated by equation 30

In equation 30, $\phi(t_j) = \phi_{min}(t_j)$.

b) Variable capacity operation between minimum and half capacity ($\phi_{min}(t_j) < L_c(t_j) \leq \phi_{haf}(t_j)$, j = k + 1 to p):

t_p is outdoor temperature when cooling load is equal to cooling minimum capacity. (The calculation method for the crossing point is described in Annex G.)

$E_{ER,\ min}(t_p)$ shall be calculated from $\phi_{min}(t_p)$ and $P_{min}(t_p)$.

t_c is outdoor temperature when cooling load is equal to cooling half capacity (refer to Annex G).

$E_{ER,\ haf}(t_c)$ shall be calculated from $\phi_{haf}(t_c)$ and $P_{haf}(t_c)$.

It is assumed that E_{ER} linearly changes depending on outdoor temperature when the capacity of equipment changes continuously.

$$E_{ER,mh}(t_j) = E_{ER,min}(t_p) + \frac{E_{ER,haf}(t_c) - E_{ER,min}(t_p)}{t_c - t_p} \times (t_j - t_p) \quad \ldots 45$$

$P_{mh}(t_j)$, power input between minimum and half capacity operation, shall be calculated from $L_c(t_j)$ cooling load and $E_{ER,\ mh}(t_j)$ by:

$$P_{mh}(t_j) = \frac{L_c(t_j)}{E_{ER,mh}(t_j)} \quad \ldots 46$$

c) Variable capacity operation between half and full capacity ($\phi_{haf}(t_j) < L_c(t_j) \leq \phi_{ful}(t_j)$, j = p + 1 to m):

t_c is outdoor temperature when cooling load is equal to cooling half capacity (refer to Annex G)

$E_{ER,\ haf}(t_c)$, Energy Efficiency Ratio (EER) at outdoor temperature t_c at half capacity operation, shall be calculated from $\phi_{haf}(t_c)$ and $P_{haf}(t_c)$ by:

$$E_{ER,haf}(t_c) = \frac{\phi_{haf}(t_c)}{P_{haf}(t_c)} \quad \ldots 47$$

t_b is outdoor temperature when cooling load is equal to cooling full capacity.

$E_{ER,\ ful}(t_b)$, Energy Efficiency Ratio (EER) at outdoor temperature t_b at full capacity operation, shall be calculated from $\phi_{ful}(t_b)$ and $P_{ful}(t_b)$ by:

$$E_{ER,ful}(t_b) = \frac{\phi_{ful}(t_b)}{P_{ful}(t_b)} \quad \ldots 48$$

It is assumed that EER linearly changes depending on outdoor temperature when the capacity of equipment changes continuously.

$$E_{ER,hf}(t_j) = E_{ER,haf}(t_c) + \frac{E_{ER,ful}(t_b) - E_{ER,haf}(t_c)}{t_b - t_c} \times (t_j - t_c) \quad \ldots 49$$

$E_{hf}(t_j)$, power input between half and full capacity operation, shall be calculated from $L_c(t_j)$ cooling load and by:

$$P_{hf}(t_j) = \frac{L_C(t_j)}{E_{ER,hf}(t_j)} \quad \ldots 50$$

d) Full capacity operation ($\phi_{ful}(t_j) < L_c(t_j)$, j = m + 1 to n):

$P_{ful}(t_j)$ shall be calculated by equation 27.

In case that the minimum capacity is not measured, the cooling seasonal energy consumption (CSEC), C_{CSE}, shall be calculated by equation 44.

a) Cyclic operation ($L_c(t_j) \leq \phi_{haf}(t_j)$, j = 1 to p):

In this range, calculation shall be made assuming that the air conditioner cyclically operates with the half operating capacity.

In equation 44, $X(t_j)$ shall be calculated by equation 30.

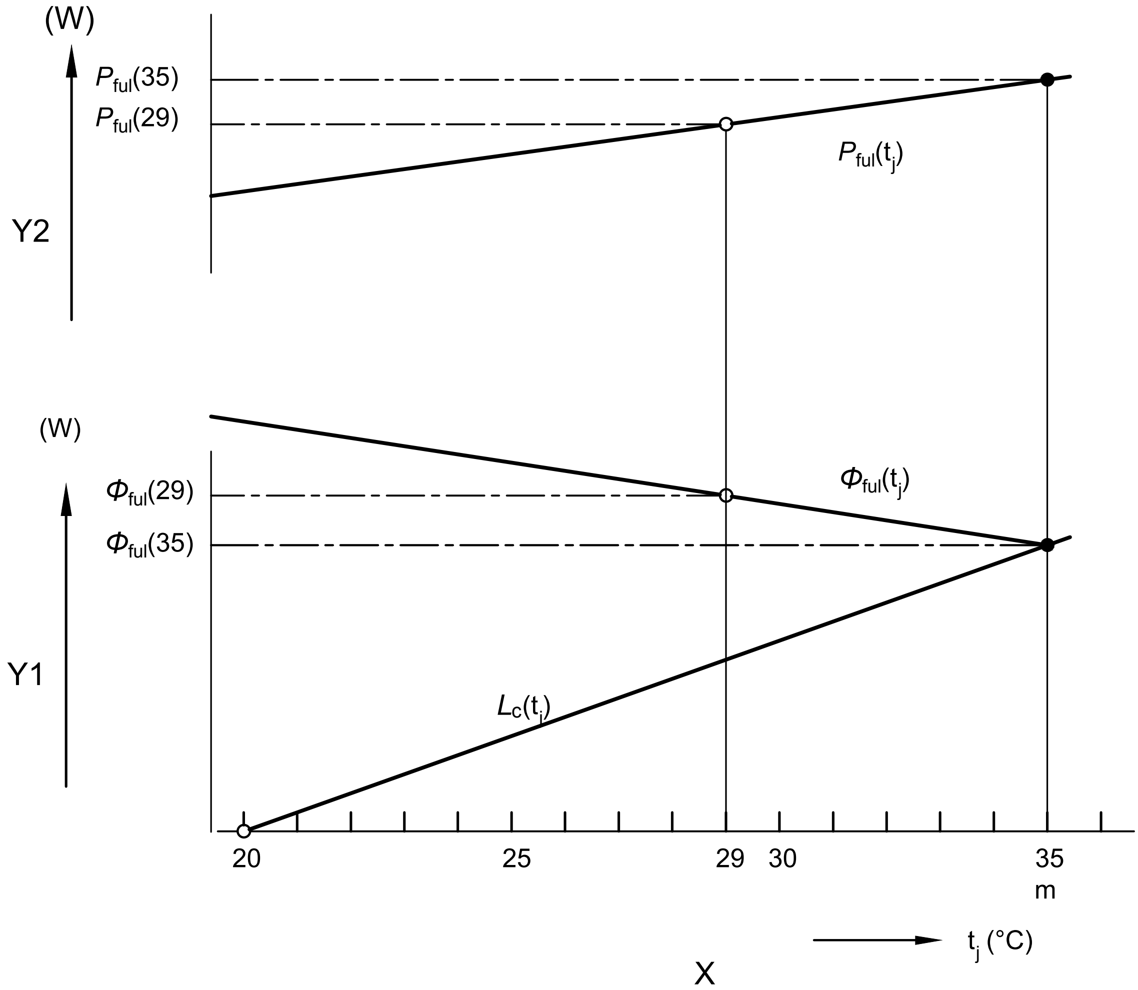
In equation 30, $\phi(t_j) = \phi_{haf}(t_j)$.

b) Variable capacity operation between half and full capacity ($\phi_{haf}(t_j) < L_c(t_j) \leq \phi_{ful}(t_j)$, j = p + 1 to m):

This calculation shall be made by using equations 47 to 50.

c) Full capacity operation ($\phi_{ful}(t_j) < L_c(t_j)$, j = m + 1 to n):

$P_{ful}(t_j)$ shall be calculated by equation 27



Key

X - OUTDOOR TEMPERATURE

Y1 - CAPACITY OR LOAD

Y2 - POWER INPUT

FIG. 16 COOLING CAPACITY, POWER INPUT AND COOLING LOAD FOR FIXED CAPACITY UNITS

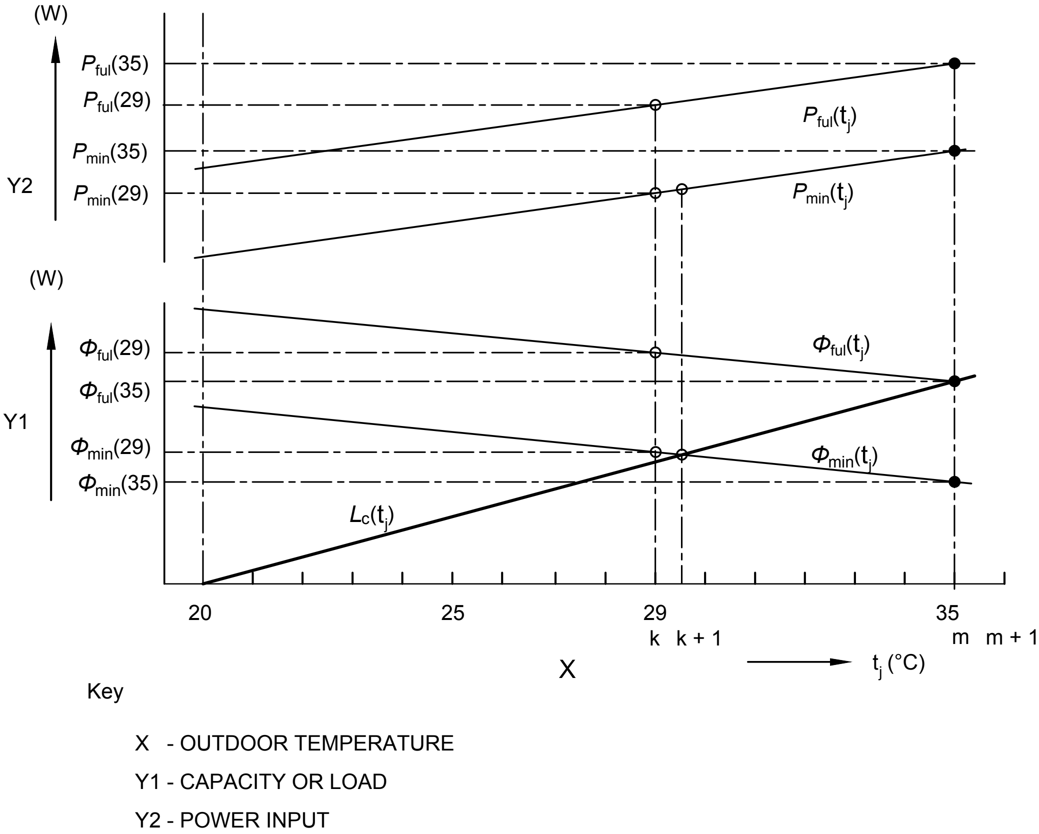


FIG. 17 COOLING CAPACITY, POWER INPUT AND COOLING LOAD FOR TWO STAGE CAPACITY UNITS

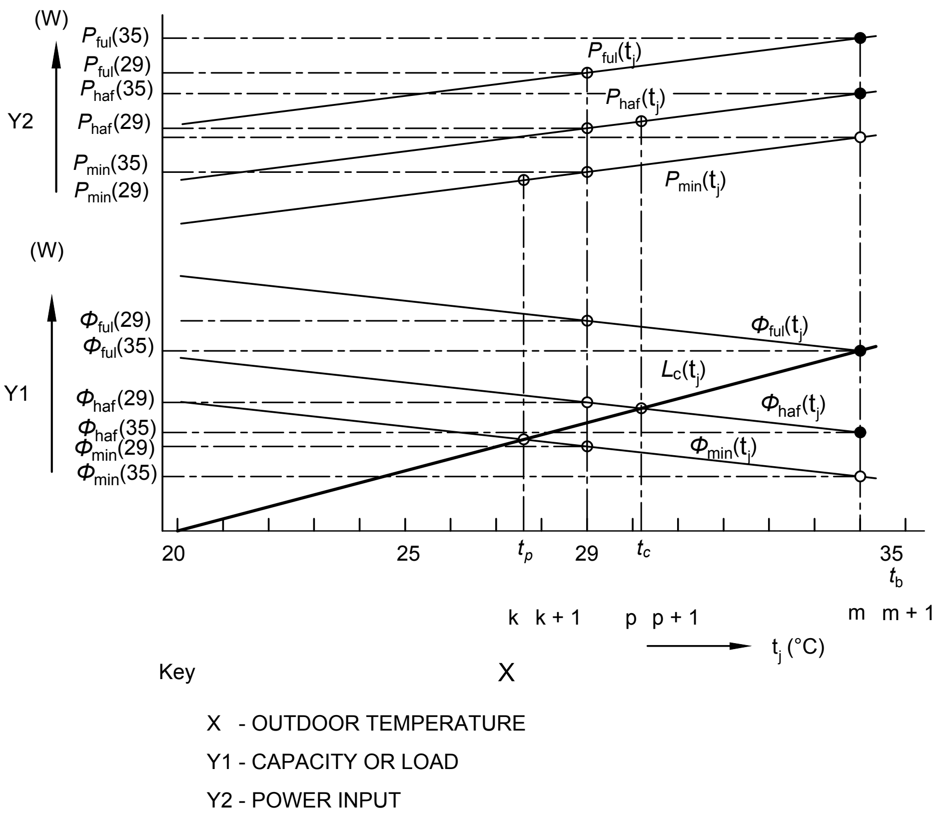
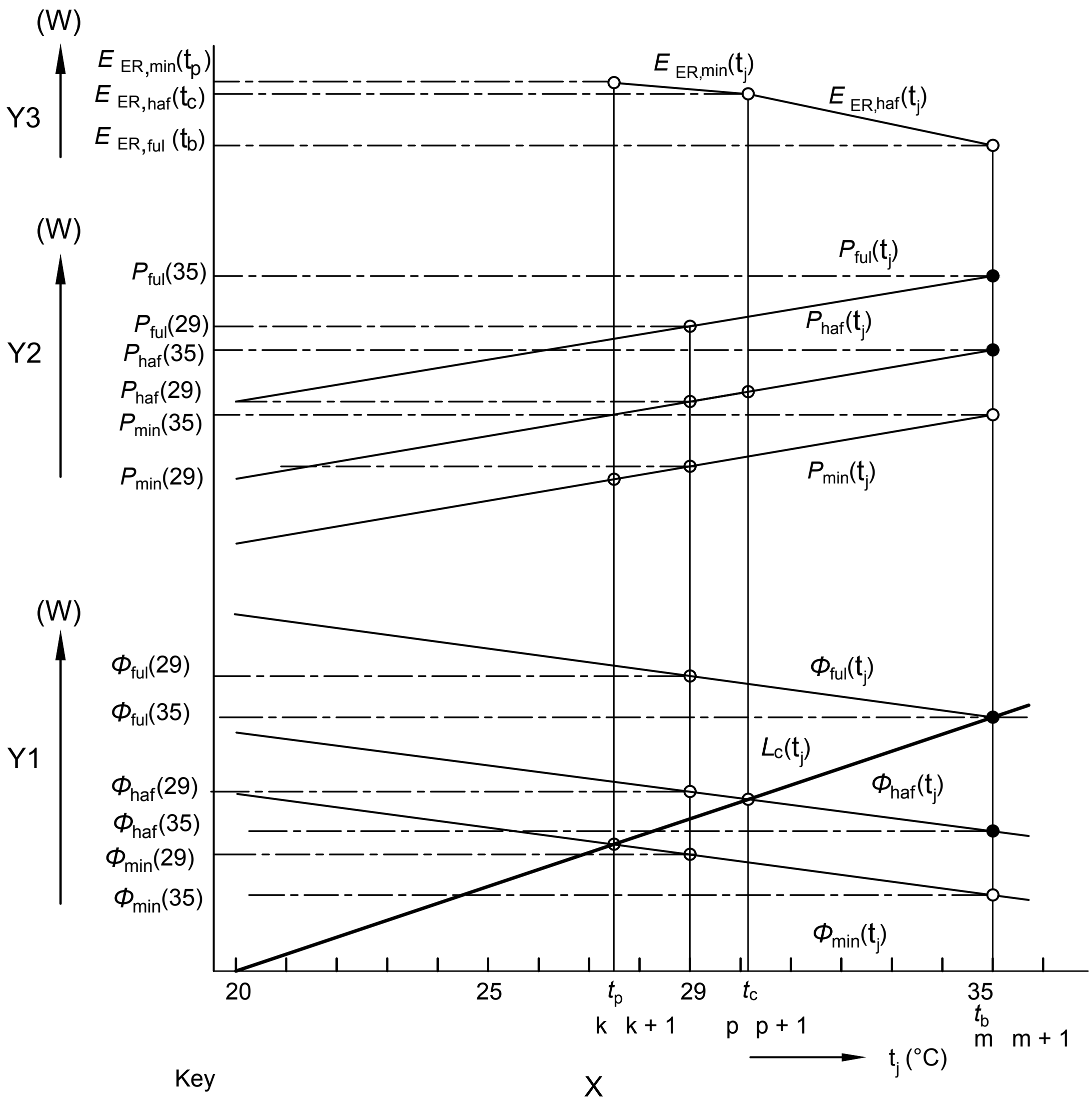


FIG. 18 COOLING CAPACITY, POWER INPUT AND COOLING LOAD FOR MULTI-STAGE CAPACITY UNITS



Key

X - OUTDOOR TEMPERATURE

Y1 - CAPACITY OR LOAD

Y2 - POWER INPUT

Y3 - ENERGY EFFICIENCY RATIO (EER)

FIG. 19 COOLING CAPACITY, POWER INPUT AND COOLING LOAD AND EER FOR VARIABLE CAPACITY UNITS

ANNEX G

(*Clause* F-7.4)

CALCULATING METHOD FOR TEMPERATURE WHEN DEFINED LOAD LINE CROSSES EACH CAPACITY LINE

Defined load $L_c(t_j)$ is calculated by equation below:

$$L_c(t_j) = \phi_{\text{ful}}(t_{100}) \times \frac{(t_j - t_0)}{(t_{100} - t_0)} \quad \dots 51$$

Each capacity characteristic $\phi(t_j)$ is given by below equations:

$$\phi_{\text{ful}}(t_j) = \phi_{ful}(35) + \frac{v_{\text{ful}}(29) - \phi_{\text{ful}}(35)}{(35-29)} \times (35 - t_j) \quad \dots 52$$

$$\phi_{\text{haf}}(t_j) = \phi_{\text{haf}}(35) + \frac{\phi_{\text{haf}}(29) - \phi_{\text{haf}}(35)}{(35-29)} \times (35 - t_j) \quad \dots 53$$

$$\phi_{\text{min}}(t_j) = \phi_{\text{min}}(35) + \frac{\phi_{\text{min}}(29) - \phi_{\text{min}}(35)}{(35-29)} \times (35 - t_j) \quad \dots 54$$

Crossing point of full capacity operation line and load line, t_b, is calculated by equation 51 and 52

$$L_c(t_j) = \phi_{\text{ful}}(t_j) \quad \dots 55$$

ANNEX H

(*Foreword*)

BASIC UNITS OF MEASUREMENT AND THEIR SYMBOLS

Sl No.	Quantity	International System (SI) Unit		Metric Units	
		Name of Unit	Symbol	Name of Unit	Symbol
i)	Air mass flow rate	kilogram per second	kg/s	kilogram per hour	kg/h
	Air volume flow rate	Cubic metre per second	m^3/s	cubic metre per hour	m^3/h
ii)	Air specific humidity	kilogram per kilogram	kg/kg	kilogram per kilogram	kg/kg
iii)	Air specific volume	cubic metre per	m^3/h	cubic metre per	m^3/kg
iv)	Air static volume pressure or dynamic pressure	newton per square metre	N/m^2	millimetre of water	mm H_2O
v)	Air velocity	metre per second	m/s	metre per second	m/s
vi)	Air volume	cubic metre	m^3	cubic metre	m^3
vii)	Area	square metre	m^2	square metre	m^2
viii)	Barometric pressure	newton per square metre	N/m^2	bar millibar millimetre of mercury (torr)	bar mbar mm Hg
ix)	Cooling effect	watt	W	kilocalorie per hour	kcal/h
x)	Dehumidifying effect	watt	W	kilocalorie per hour	kcal/h
xi)	Electric current input	ampere	A	ampere	A
xii)	Electric frequency	hertz	Hz	hertz	Hz
xiii)	Electric power input	watt	W	watt	W
xiv)	Specific enthalpy	joule per kilogram	J/kg	kilocalorie per kilogram	kcal/kg
xv)	Rotating speed	radian per second	rad/s	turn per second turn per minute	tr/str/min
xvi)	Heat flow rate	watt	W	kilocalorie per hour	kcal/h
xvii)	Heat leakage rate	watt	w	kilocalorie per hour	kcal/h
xviii)	Linear measurements	metre millimetre	m mm	metre millimetre	m mm
xix)	Temperature Interval of temperature	kelvin	K	degree Celsius	°C
xx)	Water mass flow rate	kilogram per second	kg/s	kilogram per hour	kg/h
xxi)	Acceleration	metre per square second	m/s^2	metre per square second	m^2

Symbols for Annexes are as given below:

Sl No.	Symbol	Description	Unit
i)	A_l	coefficient, heat leakage	J/(s·K)
ii)	A_n	nozzle area	m^2
iii)	c_{pa1}	specific heat of moist air entering indoor-side[b]	$J/(kg^b·K)$
iv)	c_{pa2}	specific heat of moist air leaving indoor-side[b]	$J/(kg^b·K)$
v)	c_{pa3}	specific heat of moist air entering outdoor-side[b]	$J/(kg^b·K)$
vi)	c_{pa4}	specific heat of moist air leaving outdoor-side[b]	$J/(kg^b·K)$
vii)	c_{pw}	specific heat of water	$J/(kg^b·K)$

Sl No.	Symbol	Description	Unit
viii)	C	airflow coefficient	Pa/(m^3/s)^2
ix)	C_d	nozzle discharge coefficient	-[a]
x)	D_e	equivalent diameter	M
xi)	D_i	diameter of circular ducts, inlet	m
xii)	D_n	nozzle throat diameter	m
xiii)	D_o	diameter of circular ducts, outlet	m
xiv)	D_t	outside diameter of refrigerant tube	m
xv)	h_{a1}	specific enthalpy of air entering the indoor-side	J/kg[b]
xvi)	h_{a2}	specific enthalpy of air leaving the indoor-side	J/kg[b]
xvii)	h_{a3}	specific enthalpy of air entering the outdoor-side	J/kg[b]
xviii)	h_{a4}	specific enthalpy of air leaving the outdoor-side	J/kg[b]
xix)	h_{f1}	specific enthalpy of refrigerant liquid entering expansion device	J/kg
xx)	h_{f2}	specific enthalpy of refrigerant liquid leaving condenser	J/kg
xxi)	h_{g1}	specific enthalpy of refrigerant vapour entering compressor	J/kg
xxii)	h_{g2}	specific enthalpy of refrigerant vapour leaving compressor	J/kg
xxiii)	h_{r1}	specific enthalpy of refrigerant entering the indoor-side	J/kg
xxiv)	h_{r2}	specific enthalpy of refrigerant leaving the indoor-side	J/kg
xxv)	h_{w1}	specific enthalpy of water or steam supplied to the indoor side test chamber	J/kg
xxvi)	h_{w2}	specific enthalpy of condensed moisture leaving the indoor side test chamber	J/kg
xxvii)	h_{w3}	specific enthalpy of condensed moisture leaving outdoor-side test chamber	J/kg
xxviii)	h_{w4}	specific enthalpy of the water supplied to the outdoor side test chamber	J/kg
xxix)	h_{w5}	specific enthalpy of the condensed water (in the case of H1 test condition) and the frost, respectively (in the case of H2 or H3 test conditions) in the test unit	J/kg
xxx)	K_1	latent heat of vaporization of water (2 460 J/kg at 15 °C)	J/kg
xxxi)	L	length of refrigerant line	m
xxxii)	L_d	length of duct	m
xxxiii)	L_m	length to external static pressure measuring point	m
xxxiv)	p_a	barometric pressure	kPa
xxxv)	p_c	test chamber equalization pressure	Pa
xxxvi)	p_e	external static pressure (ESP)	Pa
xxxvii)	p_{isc}	internal static pressure drop of the indoor coil cabinet assembly measured from the cooling capacity test	Pa
xxxviii)	p_m	external static pressure (p_e during the blowing test)	Pa
xxxix)	p_n	absolute pressure at nozzle throat	Pa
xl)	p_v	velocity pressure at nozzle throat or static pressure difference across the nozzle	Pa
xli)	P_{fan}	estimated fan power to circulate indoor air	W
xlii)	P_i	power input, indoor-side data	W

Sl No.	Symbol	Description	Unit
xliii)	P_K	power input to the compressor	W
xliv)	P_t	total power input to the equipment	W
xlv)	q_m	air mass flow rate	kg/s
xlvi)	q_r	refrigerant flow rate	kg/s
xlvii)	q_{ro}	refrigerant and oil mixture flow rate	kg/s
xlviii)	q_v	air volume flow rate	m^3/s
xlix)	q_{vi}	air volume flow rate, outdoor-side	m^3/s
l)	q_{vo}	air volume flow rate, outdoor-side	m^3/s
li)	q_w	condenser water flow rate	kg/s
lii)	q_{wc}	rate at which water vapour is condensed by the equipment	kg/s
liii)	q_{wo}	water mass flow supplied to the outside test chamber for maintaining the test conditions	kg/s
liv)	Re	Reynolds number	-[a]
lv)	SHR	Sensible heat ratio	-[a]
lvi)	T	thickness of tubing insulation	m
lvii)	t_a	temperature, ambient of compressor calorimeter	°C
lviii)	t_{a1}	temperature of air entering the indoor-side, dry bulb	°C
lix)	t_{a2}	temperature of air leaving the indoor-side, dry bulb	°C
lx)	t_{a3}	temperature of air entering the outdoor-side, dry bulb	°C
lxi)	t_{a4}	temperature of air leaving the outdoor-side, dry bulb	°C
lxii)	t_c	temperature of surface of condenser of the compressor calorimeter	°C
lxiii)	t_e	temperature of surface of evaporator of the compressor calorimeter	°C
lxiv)	t_{w1}	temperature of water entering condenser of the compressor calorimeter	°C
lxv)	t_{w2}	temperature of water leaving condenser of the compressor calorimeter	°C
lxvi)	v_a	velocity of air, at nozzle	m/s
lxvii)	v_n	specific volume of dry air portion of mixture at nozzle[b]	m^3/kg[b]
lxviii)	v'_n	specific volume of dry air portion of mixture at nozzle	m^3/kg
lxix)	W_1	mass of cylinder and bleeder assembly, empty	g
lxx)	W_3	mass of cylinder and bleeder assembly, with sample	g
lxxi)	W_5	mass of cylinder and bleeder assembly, with oil from sample	g
lxxii)	W_{i1}	specific humidity of air entering the indoor-side[b]	kg/kg[b]
lxxiii)	W_{i2}	specific humidity of air leaving the indoor-side[b]	kg/kg[b]
lxxiv)	W_n	specific humidity at nozzle inlet[b]	kg/kg[b]
lxxv)	W_r	water vapour (rate) condensed	kg/s
lxxvi)	X_o	concentration of oil to refrigerant-oil mixture	-[a]
lxxvii)	X_r	mass ratio, refrigerant to refrigerant-oil mixture	-[a]
lxxviii)	Y	expansion factor	-[a]
lxxix)	α	pressure ratio	-[a]
lxxx)	α_a	Interconnecting tubing heat transfer coefficient	$W/(m^2 \cdot K)$

Sl No.	Symbol	Description	Unit
lxxxi)	λ	thermal conductivity	W/(m·K)
lxxxii)	v	kinematic viscosity of air	m^2/s
lxxxiii)	$\eta_{fan,i}$	estimated indoor fan static efficiency	-[a]
lxxxiv)	$\eta_{mot,i}$	estimated indoor motor efficiency	-[a]
lxxxv)	$\sum P_{ic}$	other power input to the indoor side test chamber (for example, illumination, electrical and thermal power input to the compensating device, heat balance of the humidification device)	W
lxxxvi)	$\sum P_{oc}$	sum of all total power input to the outdoor side test chamber, not including power to the equipment under test	W
lxxxvii)	ϕ_c	heat removed by the cooling coil in the outdoor-side test chamber	W
lxxxviii)	ϕ_{ci}	heat removed by cooling coil in the indoor-side test chamber	W
lxxxix)	ϕ_d	latent cooling capacity (dehumidifying)	W
xc)	ϕ_e	heat input to evaporator of compressor calorimeter	W
xci)	ϕ_{hi}	heating capacity, indoor-side test chamber	W
xcii)	ϕ_{ho}	heating capacity, outdoor-side test chamber	W
xciii)	ϕ_{li}	heat leakage into the indoor side test chamber through walls, floor and ceiling	W
xciv)	ϕ_{lo}	heat leakage out of the outdoor side test chamber through walls, floor and ceiling	W
xcv)	ϕ_{lp}	heat leakage into the indoor-side test chamber through the partition separating the indoor-side from the outdoor-side	W
xcvi)	ϕ_L	line heat loss in interconnecting tubing	W
xcvii)	ϕ_{sci}	sensible cooling capacity, indoor-side	W
xcviii)	ϕ_{tc}	refrigerating capacity of a refrigerant compressor	W
xcix)	ϕ_{tci}	total cooling capacity, indoor-side	W
c)	ϕ_{tco}	total cooling capacity, outdoor-side	W
ci)	ϕ_{thi}	total heating capacity, indoor-side	W
cii)	ϕ_{tho}	total heating capacity, outdoor-side	W

a dimensionless value

b it means the mass of dry air; the mass, kg of denominator in this unit is based on dry air (or da). for units practically used in the air conditioning field, ‘kg (da)’ is very often used for denominator. Example; j/kg(da), m3/kg(da), kg/kg(da)

NOTE — all parameters are in relation to the unit being tested unless specified otherwise.

ANNEX J

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
Indian Institute of Technology, Roorkee	Prof (Dr) Ravi Kumar (***Chairman***)
Annapurna Electronics and Services Ltd, Hyderabad	Shri G. K. Prasad Shri J. S. Sastry (*Alternate*)
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AMENDMENT NO. 1 JUNE 2021

TO

IS 8148 : 2018 DUCTED AND PACKAGE AIR-CONDITIONERS — SPECIFICATION

(Second Revision)

(*Page* 1, *clause* **1**) — Insert the following note at the end:

'NOTE — Standard for Treated Fresh Air Unit (TFA) is under consideration'

[*Page* 1, *clause* **1.3** f)] — Insert the following at the end:

'g) Units with 100 percent fresh air intake requirements;

h) Roof top units;

j) Efficiency rating (ISEER) of the water-cooled air conditioners and air to air heat pump; and

k) Multi type air-conditioner system comprising one or more outdoor units with the combination of ducted and ductless types indoor units like Hi-wall/ cassette and ducted.'

(*Page* 1, *clause* **2**) — Insert the following new entry:

'*IS No.*	*Title*
10617 : 2018	Hermetic compressors — Specification (*second revision*)
IS 15575 (Part 1) : 2016/ IEC 61672-1 : 2013	Electroacoustics — Sound Level Meters Part 1 Specifications (*first revision*)'

(*Page* 1, *clause* **3.1,** *line* 11) — Delete 'or without'.

(*Page* 2, *clause* **4.2**) — Substitute 'IS 9844' *for* '**3** of IS 101 (Part 6/Sec 1)'.

(*Page* 2, *clause* **4.5**) — Substitute 'IS 9844' *for* '**3** of IS 101 (Part 6/Sec 1)'.

Price Group 2

(*Page* 3, *clause* **4.8,** *line* 1) — Substitute 'may' *for* 'shall'.

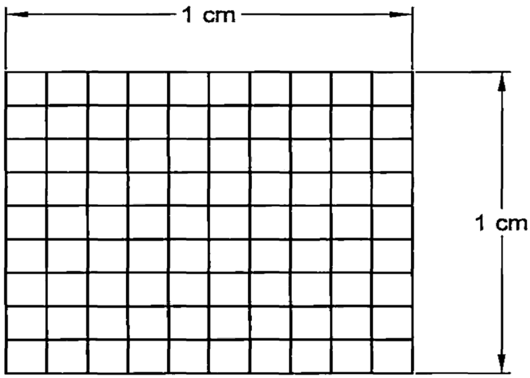
(*Page* 3, *clause* **4.10,** *line* 1) — Delete 'and refrigeration piping'.

(*Page* 3, *clause* **4.11**) — Substitute the following for the existing:

'4.11 Air Filter

The air filter with following specifications shall be used which may be made from synthetic or any other suitable material.

The filter used on the evaporator coil of the unit shall have a 65^{+5}_{-0} percent open area when measured in an area of 1 cm^2 . The measurement shall be made by measuring the wire diameter. Count the number of wires in 1 cm^2 to calculate closed area, deduct overlap area and calculate the total closed area. Actual open area percent = (Total area – closed area) / Total area × 100. A specimen of the cut piece removed from the filter for the purpose of measurement is shown below for guidance.'



(*Page* 3, *clause* **4.11**) — Insert the following new clauses at the end of the clause:

'4.12 Compressors

The compressors shall conform to IS 10617.

4.13 Motors

The motor used for driving the fan/blower motor shall be either capacitor type induction motors or brushless d. c. motor (BLDC).

The capacitor type induction motor shall comply with the requirements given in IS 996 as applicable for fan duty motors.

In the case of BLDC motors, the test for full load test shall be carried out at the rated frequency declared by the manufacturer. The measured power input and the speed shall be within ± 10 percent of the declared value. In addition, BLDC motors shall comply with the following requirements as specified in the respective clauses of IS 996 as applicable:

a) Dimensions (*see* **7.1**);

b) Terminal box (*see* **9.2**);

c) Mounting (*see* **9.3**);

d) Constructional features (*see* **9.4**);

e) Enclosure (*see* **10** of IS 996 and IP code as per IS/IEC 60529 : 2001);

f) Method of cooling (*see* **11**);

g) Full load test for measurement of power input and full load speed at the declared frequency (*see* **12.5** and **F-6.2.4**);

h) Insulation resistance excluding the requirement of temperature rise test (*see* **12.7**);

j) High voltage (*see* **13.1**); and

k) Moisture proofness (*see* **13.2**).

NOTE — Separate standards for BLDC motor is under development. Requirement of overload protector, the centrifugal switch and capacitor from IS 996 does not apply for BLDC motor.

4.14 Temperature Sensing Control

Temperature sensing controls shall conform **8** to **28** of IS/IEC 60730-2-9 as applicable.'

(*Page* 3, *clause* **5.1**) — Insert following at the end of clause:

'The ISEER of production unit shall not be less than 90 percent of the rated value.

Capacity at half load for variable capacity units shall be within ± 10 percent of rated half load capacity.

Power at half load for variable capacity units shall not exceed the rated half load power by more than 10 percent.'

[*Page* 4, *clause* **7.1** d)] — Substitute ‘0.2 m^3/h/kW’ *for* ‘0.2 m^3/h’.

[*Page* 4, *clause* **7.1** f)] — Insert the following at the end of clause:

‘g) Fan / Blower speed — Speed declared by the manufacturer.’

[*Page* 4, *clause* **7.3** d)] — Substitute ‘0.2 m^3/h/kW’ *for* ‘0.2 m^3/h’.

[*Page* 5, *clause* **7.4** d)] — Substitute ‘0.2 m^3/h/kW’ *for* ‘0.2 m^3/h’.

[*Page* 5, *clause* **7.5** d)] — Substitute ‘0.2 m^3/h/kW’ *for* ‘0.2 m^3/h’.

(*Page* 6, *clause* **8.3.3,** *sentence* 1 *and* 2) — Substitute the following for existing:

‘The test voltage shall be adjusted as specified in **7.3**. These voltages shall be maintained at the test voltages ±1 percent under running conditions.’

(*Page* 6, *clause* **8.3.4,** *sentence* 1) — Delete ‘and equilibrium condensate level’.

(*Page* 7, *clause* **8.5.2**) — Insert the following at the end of the clause:

‘In case unit start cycling on low pressure (LP) cut off or temperature control, test to be continued for 6 cycle or 2 h, whichever is lower.’

(*Page* 7, *clause* **8.6.3**) — Substitute the following for existing clause:

‘**8.6.3** *Procedure*

After establishment of the specified temperature conditions, the equipment shall be started and operated continuously for a period of 4 h.’

(*Page* 7, *clause* **8.6.4**) — Substitute the following for the existing clause:

‘**8.6.4** *Requirements*

When operating under the test conditions specified in **7.5**, no condensed water shall drip or blow from the equipment.

No running of condensed water on unit body/connected duct and no accumulation of water on body is acceptable.

Equipment which rejects condensate to the condenser air shall dispose of all condensate and there shall be no dripping or blowing-off of water from the equipment such that the building or surroundings become wet.'

(*Page* 7, *clause* **8.7.4**) — Substitute the following for the existing clause:

'**8.7.4** *Requirements*

When operating under the test conditions specified in **7.5**, no condensed water shall drip or blow from the equipment.

No running of condensed water on unit body/connected duct and no accumulation of water on body is acceptable.

Equipment which rejects condensate to the condenser air shall dispose of all condensate and there shall be no dripping or blowing-off of water from the equipment such that the building or surroundings become wet.'

(*Page* 11, *clause* **10.2.3) —** Insert the following new clauses at the end of the clause:

'10.3 Instruments

10.3.1 *Temperature Measuring Instruments*

Instrument accuracy shall be within the following limits:

a) Wet bulb and dry bulb temperatures of reconditioned air in room side calorimeter compartment, ±0.1°C;

b) Water temperatures, outdoor side compartment conditioning coil, ±0.1°C.

c) All other temperatures, ±0.5°C.

NOTE — In all measurements of wet bulb temperature, sufficient wetting shall be provided and sufficient time shall be allowed for the state of evaporative equilibrium to be attained.

10.3.1.1 Whenever possible, temperature measuring instruments used to measure the change in temperature should be arranged so that they can be readily interchanged between inlet and outlet positions to improve accuracy.

10.3.2 *Pressure Measuring Instruments*

10.3.2.1 Accuracy of pressure measuring instruments, without including barometers should permit measurements within ±1 N/m^2 (0.01 m bar) (0.1 mm H_2O).

10.3.2.2 Barometric pressure shall be measured by a barometer having accuracy within ± 0.5 percent of full scale.

10.3.3 *Electrical Instruments*

Electrical measuring instruments shall have accuracy of ± 0.5 percent of the quantity measured.

10.3.4 *Water Flow Measuring Instruments*

Volume measurements shall be made with either of the following instruments having an accuracy of ± 1.0 percent of the quantity measured:

a) Liquid quantity meter, measuring either mass or volume; and
b) Liquid flow rate meter.

10.3.5 *Sound Measuring Instrument*

Sound level meter shall conform to the class 2 of IS 15575 (Part 1) : 2016/ IEC 61672-1 : 2013.

10.3.6 *Time*

Time interval measurements should be made with instruments whose accuracy is ± 0.2 percent of the quantity measured.'

[*Page* 11, *clause* **11.5** a)] — Substitute the following for the existing:

'a) Unit is installed as it is installed for cooling capacity test and the air flow meter is disconnected. Connect the duct of minimum 1 m length and maintain the CFM equivalent to cooling capacity test by varying the RPM of the blower/fan and/or connect damper as applicable.'

(*Page* 12, *clause* **12.2.3**) — Delete.

(*Page* 12, *clause* **12.2.4**) — Substitute the following for the existing clause:

'**12.2.4** *Electric Strength Test*

The insulation of the appliance is subjected to a voltage of substantially sinusoidal waveform having a frequency of approximately 50 Hz for 1 s as described in **A-2** of IS 302-1. The value of the test voltage and the points of application shall be in accordance with Table 19 of IS 302-1. For inverter units or units with surge

protection, remove the earthing wire of the inverter drive/surge protection device before testing, as Variable Frequency Drives (VFDs) provide a ground path for noise (electrical) filter.

During the test no breakdown shall occur.'

(*Page* 13, *clause* **12.2.5**) — Delete

(*Page* 13, *clause* **12.2.6**) — Substitute the following for the existing clause:

'**12.2.6** *Earthing Continuity Test*

The earthing continuity test shall be carried out in accordance with method prescribed in **A-1** of IS 302-1.

The voltage drop is measured and the resistance is calculated. It shall not exceed:

a) for the appliances having a supply cord, 0.1 Ω or 0.2 Ω plus the resistance of the supply cord; and
b) for the other appliances, 0.1 Ω.

NOTES

1 The test is only carried out for the duration necessary to enable the voltage drop to be measured.

2 Care is to be taken to ensure that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.'

(*Page* 13, *clause* **12.3.3**) — Substitute the following for the existing clause:

'**12.3.3** *Safety Tests*

The following type of safety tests are to be carried out as per IS 302-1:

a) Protection against access to live part (*see* **8**);
b) Leakage current at operating temperature (*see* **13.1**);
c) Electric strength test at operating temperature (*see* **13.2**); and
d) Provision for earthing (*see* **27**).'

(*Page* 17, *clause* **B-2.2**) — Delete.

(*Page* 17, *clause* **B-2.5,** *line* 4) — Substitute 'min 5 m' *for* 'within 5 to 7.5 m'.

(*Page* 31, *clause* **F-1**) — Insert the following note at the end of the clause:

'NOTE — For water cooled condenser system ISEER and heat pumps calculation method is under consideration till such time full load COP shall be used for energy efficiency.'

(*Page* 38, Annex G) — Insert the following note at the end of the clause:

'NOTE — For water cooled condenser system ISEER and heat pumps calculation method is under consideration till such time full load COP shall be used for energy efficiency.'

(*Page* 38, Annex G, equation 52) — Substitute 'Φ_{ful}(29)' *for* 'υ_{ful}(29)'.

(MED 03)

Publication Unit, BIS, New Delhi, India